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RCRA Facility Investigation Report
Pawtuxet River

Former CIBA Site
Cranston, Rhode Island

Volume 1:
RFI Report

Submitted by:

CIBA Corporation

Route 37 West
Toms River, New Jersey 08754

31 March 1996



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Regional Remediation Team

REC'D 4-1-96
F. G.



March 29, 1996

Ciba-Geigy Corporation
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Mr. Frank Battaglia, Project Manager
USEPA Region I
Waste Management Building
90 Canal Street
Boston, MA 02114

**Subject: Submittal of the RCRA Facility Investigation Report
for the Pawtuxet River
Ciba Corporation
Cranston, Rhode Island**

Dear Mr. Battaglia:

Ciba, Woodward-Clyde Consultants, PTRL Environmental Services, and HydroQual, Inc. are pleased to submit this Pawtuxet River RCRA Facility Investigation Report to USEPA for review and comment. This report presents the results of our comprehensive investigation - with specific emphasis on evaluating the potential environmental impacts to the river from RCRA regulated activities at the Site, primarily within the former Production Area.

This document consists of three volumes.

- Volume 1 - *Pawtuxet River RFI Report* - presents the results of the physical characterization, source characterization, release characterization and summarizes the results of the river modeling investigation and Baseline Ecological Risk Assessment.
- Volume 2 - *Pawtuxet River Modeling Investigation* - details the results of the hydrodynamic modeling, sediment transport modeling, and fate and transport of contaminants. It also discusses the prediction of selected contaminant concentrations in sediment under existing and future conditions.
- Volume 3 - *Baseline Ecological Risk Assessment* - provides a detailed analysis of the toxicity to benthic invertebrates, fish, raccoons, and herons within the Upstream, Facility, and Downstream Reaches of the Pawtuxet River.

Each volume is a stand-alone report; each report can be reviewed individually. Volume 1, provides the best overview of this investigation.



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TIEs

Ciba requests that USEPA substitute Volume 3 - Baseline Ecological Risk Assessment for the Toxicity Identification Evaluations (TIEs) which were specified in the revised Pawtuxet River Phase II Proposal. The TIEs that were originally proposed would have identified a group of compounds that caused toxicity in the Facility Reach using bioassay type methodologies and chemical analysis without pinpointing specific contaminants. In contrast, and to the benefit of this project, the Baseline Ecological Risk Assessment was able to not only identify groups of chemicals but also, as intended, evaluated specific contaminants (PAHs, metals, etc.) related to the Site (PCBs, VOCs, etc.) as well as in the Upstream and Downstream Reaches. The Baseline Ecological Risk Assessment provides a broad and relatively accurate picture of the causes of toxicity in the Pawtuxet River. Finally, in our opinion, it is unlikely that individual TIEs would have provided as clear a picture or, for that matter, any conclusive results.

MPS

As reported previously, Ciba is proceeding now to develop Media Protection Standards (MPS) for the groundwater flowing from the Production Area through the river sediments and into the surface waters. Based on the sampling data and results of the Baseline Ecological Risk Assessment, we have already concluded that no MPS are necessary for surface water. The sediment (pore water concentrations) has been defined as the potentially affected media for protection. The compounds of potential concern in the groundwater are volatile organic compounds (VOCs), primarily chlorobenzene, ethylbenzene, toluene and xylenes. We will develop specific MPS for each of these compounds in groundwater and will submit the recommended concentrations to the USEPA in a letter report at the end of April, 1996.

Corrective Measure Study Report

The Corrective Measures Study (CMS) for the Pawtuxet River is scheduled to be submitted to USEPA by the end of June, 1996. Based on the results of the Pawtuxet River RCRA Facility Investigation, Ciba is confident that this schedule can be met. Because IRMs have already been performed (installed groundwater capture system and dredged contaminated sediment), only a limited number of alternatives are applicable for evaluation. Ciba proposes to prepare a focused CMS Report for the Pawtuxet River, similar to the On-site CMS Report. The Pawtuxet River CMS Report will also address stabilization issues. It will



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Cyanide

The Baseline Ecological Risk Assessment identified cyanides as a compound that, based on limited sediment and surface water results, may be causing river-wide toxicity. Due to the lack of data and the fact that cyanide is not a Site related compound, it was not investigated further in the RFI or Baseline Ecological Risk Assessment. The primary question is how much cyanide is bound up with sulfides in the sediment or free to leach into the pore waters. We believe that cyanide may be a concern for the USEPA or the Rhode Island Department of Environmental Management.

If there are any questions regarding these reports, please call me at (908) 914-2715

Very truly yours,

B. J. Berdahl, Ph.D., C.H.M.M.
Project Coordinator

cc: D. Aschman (RIDEM)
Mayor Traficante (Cranston)
Mayor Chaffee (Warwick)
Cranston Central Public Library
J. Lake (AED NHEERL)
C. Barr (USEPA Laboratory)

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EXECUTIVE SUMMARY

ES. 1 OVERVIEW

This document presents the results of the RCRA Facility Investigation (RFI) for the Pawtuxet River that was conducted as part of the RCRA Corrective Action Study at the CIBA-GEIGY facility in Cranston, Rhode Island (Figure ES-1). A separate RFI was conducted to address the investigation on-site. The results of the on-site RFI were submitted in July 1995 in the RCRA Facility Investigation Report On-Site Areas. The Pawtuxet River RFI involved five main tasks - a physical characterization, a source characterization, a release characterization, river modeling (hydrodynamic, sediment transport, and fate and transport of contaminants), and an ecological risk assessment. The RFI was conducted in two phases with work initiating in 1989 and concluding with the submittal of this report. The results of the physical, source and release characterizations are included in this volume of the report. The Pawtuxet River modeling results are presented in Volume 2 and the ecological risk assessment is presented in Volume 3.

ES. 2 BACKGROUND

The Alrose Chemical Company manufactured chemicals at the Site beginning in 1930. The GEIGY Chemical Company purchased the Site in 1954 and merged with the Ciba Corporation in 1970. The facility operated until May 1986. Throughout its operational history, the Site was used for the manufacturing of various agricultural products, leather and textile auxiliaries, plastics additives, optical brighteners, pharmaceuticals and bacteriostats.

An Administrative Order of Consent (Order) in which Ciba agreed to conduct a RCRA Corrective Action Study at the Site was issued to Ciba. The Order became effective on 16 June 1989. There are four stages to a RCRA Corrective Action Study: a RCRA Facility Assessment (RFA), a RCRA Facility Investigation (RFI), a Corrective Measures Study (CMS) Proposal and a Corrective Measures Study Report. The RFA, conducted by USEPA prior to the Order, determined that known and/or suspected releases of hazardous materials had occurred at the Site.

The RFI was conducted to characterize the impact of known or suspected releases that were determined by the RFA to require further investigation. This report contains the results of the RFI for the Pawtuxet River. The requirement for developing a CMS Proposal (Stage 3 of the RCRA Corrective Action Study) was waived for this investigation, as agreed with USEPA. The CMS Report evaluates the technologies available to achieve the Media Protection Standards. The CMS Report for the Pawtuxet River is scheduled for submittal in June 1996.

ES.3 PHYSICAL CHARACTERIZATION

The primary objective of the physical characterization phase of the River RFI was to describe the hydrology of the Pawtuxet River. Physical and chemical attributes of the river water and sediment were characterized. Several tasks were completed to satisfy this objective: an extensive literature review was conducted, river flow was characterized, river bathymetry was mapped and the physical characteristics of river sediments were described.

The results of these tasks indicate that the Pawtuxet River, within the study area, is a fourth order stream that drains about 230 square miles of mixed industrial and urban land. Flow in the river is regulated by reservoirs upstream. The river is classified by RIDEM as "Class D" upstream of the facility - Class D waters are suitable for migration of fish and have good aesthetic value, but should not be used for drinking or contact recreation. The average daily flow in the river is about 350 cfs. Highest flows occur in April; lowest flows occur in August. In the 4.5 mile section of river from the Cranston gauge to Pawtuxet Cove Dam, the river varies from about 60 to 200 feet wide, with mid-channel depths of 3 to 14 feet. Sediment thickness ranges from 0 to 4 feet thick, based on manual probing of the sediment. Depositional zones, or areas where sediments are thicker, tend to occur on the inside bends of the river and just downstream of large pools. Sediment within these Depositional zones is typically characterized by high Total Organic Carbon content, higher percentage of fine grained materials and higher Cation Exchange Capacities.

ES. 4 SOURCE CHARACTERIZATION

During the On-Site RFI, the Solid Waste Management Units (SWMUs), Areas of Concern (AOCs) and Additional Areas of Investigation (AAOIs) that have been identified in the RFA were studied to characterize the wastes contained at these locations and evaluate their potential for release of contamination into the environment. For the Pawtuxet River RFI, potential source areas were reviewed to see if any of these potential sources may have impacted the river. The potential sources from on-site activities which may have impacted the Pawtuxet River include shallow groundwater from the Production and Warwick Areas and historical releases of waste water from the Waste Water Treatment Area. Also, sediment located within the old Cofferdam Area, adjacent to the Production Area, may have provided a source of contamination to the river prior to being excavated voluntarily during the IRM conducted in 1995.

ES. 5 RELEASE CHARACTERIZATION

The objective of the release characterization was to define the spatial distribution of potential contaminants in river water and sediments. Water and sediment samples were collected from transects located upstream, adjacent to and downstream of the Site during two rounds of sampling within each of the two phases of this study. Water and sediment quality were compared between upstream, facility and downstream reaches of the river. Results of this investigation show that releases of zinc, PCBs, chlorobenzene, toluene and bis(2-ethylhexyl)phthalate have impacted Pawtuxet River sediments in the immediate vicinity of the Site. Sediments within the Upper Facility Reach (adjacent to the Production Area) show statistically significantly higher concentrations of these analytes than sediments upstream or downstream of this reach. The impact of releases from the Site appears to be localized in the sediment adjacent to the facility.

ES. 6 MODELING OF THE PAWTUXET RIVER

The modeling portion of this study included collection of water column and sediment contaminant data and development of a mathematical modeling framework to evaluate the fate and transport of contaminants in the river. The modeling framework provides a quantitative

basis for evaluating the effects of various remediation alternatives on contaminant levels in the Pawtuxet River.

The modeling framework used in this study represents the state-of-the-art in scientific understanding of the relevant environmental mechanisms influencing the transport and fate of contaminants in surface waters. The model is a mathematical representation of the transport and transfer processes that control the temporal and spatial distributions of a chemical in the environment. The framework is comprised of three sub-models: the 1) hydrodynamic, 2) sediment transport, and 3) chemical fate components.

The hydrodynamic sub-model calculates spatial and temporal velocity (and flow) distributions, water depths, advective and dispersive mixing processes, and bottom shear stresses. The two dimensional, vertically integrated hydrodynamic model properly accounts for lateral variations in shear stress at the sediment-water interface, which strongly influences the transport and fate of sorbed chemicals due to cohesive sediment transport.

The sediment transport sub-model simulates the resuspension and settling of particulate material in the system and the concurrent transport of solids downstream. Because hydrophobic chemicals preferentially adsorb onto fine grained, cohesive sediments, the resuspension, deposition, and transport of cohesive sediments plays a critical role in the fate of hydrophobic chemicals in an aquatic system. Non-cohesive solids are generally less important as a sorptive phase for hydrophobic contaminants, but deposition of non-cohesive solids can provide a dilution of in-place contaminated sediments. The formulations used to describe non-cohesive sediment transport have been developed over a longer period of time, compared to the more recent advances in cohesive sediment transport. Both non-cohesive and state-of-the-art cohesive particle transport formulations are included in the sediment transport model applied to the Pawtuxet River, producing realistic simulations of suspended sediment transport processes. The results of the sediment transport sub-model provide input to the contaminant fate sub-model.

The contaminant fate sub-model uses the information generated by the hydrodynamic and sediment transport sub-models to define contaminant transport within the system. The fate sub-model is based on a mechanistic framework for the transport and transfer of contaminants in

the aqueous environment. This sub-model includes such processes as dissolved-particulate partitioning, volatilization, settling, resuspension, and diffusion. The results of the contaminant fate model are estimates of future concentrations which vary in response to alternate remediation activities.

The general approach in the development of mathematical models of the fate and transport of chemicals in the environment is to: 1) collect and analyze relevant environmental data, 2) select and develop a model framework, 3) calibrate the model with ambient data, and 4) project future environmental conditions. These four steps have been followed in this study to produce a comprehensive model for determining the fate and transport of chemicals in the Pawtuxet River.

The significant findings of the fate and transport modeling are:

- The lower 2.8 km of the study area (from approximately 0.5 km upstream of the Facility to the Pawtuxet Cove Dam) is, in general, a depositional area. Net resuspension is calculated in only very limited areas. A reduction in the slope of the river bed causes net deposition to begin roughly 0.5 km upstream of the facility.
- Re-deposition of sediments resuspended from within the study area is not a significant component in the depositional processes in the study area. Therefore, sediment contaminant concentrations in downstream areas are not significantly affected by resuspension of contaminated sediment from locations within the study area.
- Deposition in the lower 2.8 km of the study area results in gradual burial of surficial sediments with upstream water column solids. The change in contaminant concentrations due to this burial is a function of the local deposition rate and the relative concentration of contaminants in the sediment and on the depositing solids.
- Sediment concentrations of chlorobenzene, naphthalene and PCBs are fairly constant in locations away from the former Cofferdam Area, indicating that sediment - water column exchanges of these chemicals are near equilibrium. Most locations in the lower 2.8 kilometers of the study area experienced an increase in zinc concentrations in the

sediment due to deposition of zinc contaminated solids. The zinc contaminated water column solids are associated with zinc entering the study area at the upstream boundary. Tinuvin 328 concentrations in most of the lower 2.8 km of the study area decreased in response to deposition of uncontaminated solids.

- Contaminant concentrations in sediments of areas away from the Production Area are not significantly affected by the operation of the groundwater capture system or the excavation of sediment from the former Cofferdam Area. Current mass fluxes out of the sediments adjacent to the Production Area do not significantly affect the sediments in the downstream Pawtuxet River.
- Operation of the groundwater capture system along the Production Area bulkhead is effective in reducing peak concentrations of chlorobenzene and naphthalene. This remedial action should be equally effective in reducing the concentrations of other chemicals with similar partition coefficients. Chlorobenzene concentrations in the top 10 cm of the sediment of the former Cofferdam Area decrease from over 3000 ppm to less than 0.1 ppm in the first two years of the simulation of the groundwater capture system. Naphthalene concentrations in the same area decrease from over 100 ppm to less than 0.1 ppm in the first three years of the simulation.
- Excavation of sediment from the former Cofferdam Area is effective in reducing concentrations of PCB, Tinuvin 328, and zinc at that location. Ten years after excavation, PCB concentrations in the top 5 cm and 5-10 cm layers are calculated at 0.6 and 1.6 ppm, respectively. These represent substantial reductions compared to concentrations calculated in the base case (no remedial action), which were 22 and 45 ppm in the top 5 cm and 5-10 cm layers, respectively. Tinuvin concentrations of 0.3 ppm, or less, in the top 10 cm, calculated ten years after excavation, are significantly lower than concentrations of several hundred ppm, calculated at the end of the no action simulation. Zinc concentrations in the 0-5 and 5-10 cm layers are initially reduced from between 1000 and 3000 ppm to approximately 200 ppm as a result of the excavation. Deposition of contaminated solids from upstream gradually increase the sediment concentrations of

zinc to approximately 550 and 330 ppm in the two layers, during the 10.6 year simulation.

- The combination of the two remedial actions produces substantial reductions in the peak concentrations of each of the five chemicals modeled. Table ES-1 summarizes the reduction in contaminant concentration in sediments near the Production Area, calculated over the course of the 10.6 year projection analyses. The indicated reductions of chlorobenzene and naphthalene concentrations are achieved in the first 2 and 3 years, respectively.

ES. 7 ECOLOGICAL RISK ASSESSMENT

This baseline ecological risk assessment of the Pawtuxet River near the Ciba-Geigy (Ciba) facility in Cranston, Rhode Island (the Site), follows the process defined by the *Framework for Ecological Risk Assessment* (USEPA, 1992) and incorporates other USEPA guidance.

The main objective of this baseline ecological risk assessment is to evaluate the potential risks posed to ecological receptors by chemicals contained in Pawtuxet River surface sediment (0-0.5 feet) and surface water. Specific objectives are to:

- review ecological data,
- summarize the data into a description of ecological conditions of the Pawtuxet River near the Site,
- review data on the chemical contamination of the shallow sediment and surface water,
- develop a conceptual model to identify reasonable exposure pathways and potential ecological receptors, and
- characterize the potential for chemicals to induce adverse ecological effect.

Terrestrial/riparian reconnaissance, fish population, and benthic invertebrate surveys were conducted at and near the Site. White suckers (*Catostomus commerson*) were numerically dominant in the river at all areas surveyed. Common carp (*Cyprinus carpio*) were common. All other fish species collected were rare. Avian species included the great blue heron (*Ardea*

herodias), mallard duck (*Anas platyrnecus*), and red-tailed hawk (*Buteo jamaicensis*). Five mammalian species were identified, including the eastern gray squirrel (*Sciurus carolinensis*) and the raccoon (*Procyon lotor*).

Potential exposure pathways for plants and animals include:

- direct contact with contaminated surface water or sediment,
- uptake through roots in contact with surface water or sediment,
- consumption (incidental ingestion) of contaminated sediment by either aquatic or terrestrial consumers, and,
- secondary exposure pathways for both aquatic and terrestrial receptors that involve ingestion of contaminants which have bioaccumulated into forage or prey items.

Potential ecological receptors were also identified. Because evaluating risks posed by chemicals to each and every species present is not feasible, the following were selected as indicator species: benthic invertebrates, fish (bluegill), raccoon, and the great blue heron. These species were selected as indicators because:

- they were observed near the Site,
- they filled a niche in the food web,
- suitable habitat is available for these species,
- they represent top predators or top predator prey species, and/or
- species-specific toxicity data was available for a number of chemicals.

The potential for adverse effects was addressed in this assessment through comparison of an observed exposure point concentration to a toxicity reference value (TRV), which is an experimental or derived no-observed-adverse-effect-level (NOAEL) for terrestrial and aquatic animals. A NOAEL is the dose or concentration at or below which a population of organisms may be exposed with no expected adverse impacts to any individuals. Thus, endpoints in this assessment were based on potential effects at the population level of biological organization (USEPA, 1989a). Measurement endpoints were published results of laboratory or field toxicity

tests performed on aquatic invertebrates, fish, mammal and avian species that share an operational relationship with previously defined assessment endpoints.

Risk from the measured contaminants was estimated for benthic invertebrates, fish, raccoons and herons by dividing the estimated exposure for each chemical to the respective TRV. This resulting value is the toxicity quotient (TQ). The TQ values provide a means for identifying those contaminants of classes of contaminants that are likely contributors to ecological effects observed in the river. For contaminants with the same mode of toxicity, summation of the TQ values provides a better estimate of the importance of those contaminants.

Overall population impacts from chemical stressors may be indicated qualitatively using the sum of all of the TQ values, termed the Ecological Toxicity Index (ETI). An ETI value of less than one is evidence that a chemical is unlikely to adversely affect the population, a value from 1 to 10 indicates that adverse effects may be possible, and ETI values exceeding 10 indicates that adverse effects for the populations are likely (See Table ES-2). Gross differences among locations in ETI values gives some indication of the relative potential impacts of contaminants at each location on population dynamics. This index can only be interpreted qualitatively, because of differences in dose/response relationships among chemicals and because of synergistic, antagonistic, or a lack of interactions among chemical effects.

A number of specific conclusions were derived from the risk assessment. They have been organized by approach and organism and are listed below.

Benthic Invertebrates

- PAHs are the greatest contributors to the ETI values for benthic invertebrates, and the summed TQ values for PAHs are high throughout the study area, suggesting that basin-wide industrial activity has contributed significantly to elevated risk levels throughout the river.
- In the Lower Facility and Downstream Reaches, pesticides and phenols are the other major contributors to the benthic invertebrate ETI values. There is no evidence that these were introduced from the Ciba facility. In addition, the spatial patterns of the summed TQ values

for these two classes is not consistent with the spatial patterns of chemicals known to be released by Ciba; the latter peak in the upper facility reach, whereas pesticide and phenol TQ values peak in the lower facility and downstream reaches.

Fish

- The ETI values for fish are relatively low (between 5 and 10). Further, they are approximately uniform over the entire study area.

Raccoons

- Metals dominate the ETI values for raccoons, except in the Upper Facility Reach prior to the IRM excavation. There were no spatial trends in the summed TQ values for metals. In addition, there is no evidence that the primary contributors to the metals TQ sum (cadmium and thallium) were released by Ciba.
- In the upper facility reach, PCBs dominated the raccoon ETI prior to the IRM excavation. The PCB TQ value declined from 51 to <0.1 as a result of the excavation.

Hérons

- Metals (primarily thallium) and pesticides dominate the ETI values for herons. There is no evidence that CIBA released the chemicals that dominate these values.

The biological observations are consistent with the results of the TQ/ETI analysis in suggesting that the stresses are a river-wide problem:

- The river, including Upstream, Facility and Downstream Reaches, is characterized by relatively stress-tolerant biota. The benthic community at almost all sites sampled was dominated by tubificid oligochaetes, a group of species that are very common in freshwater environments, especially in chemically-impacted lakes and streams.

- Several fish species exhibit abnormalities in the Upstream Reach, Facility Reach and Downstream Reach. The overall proportion of abnormal fish decreases steadily from the Upstream Reach to the Downstream Reach. Thus, the fish collected in the Facility Reach do not exhibit a particularly high proportion of abnormalities.
- Species richness, dominance and diversity indices for the benthic community exhibit no consistent spatial trend.

In a few cases, contaminants (PCBs, VOCs, and Zinc) at elevated concentrations in sediments adjacent to the Ciba Facility Production Area contributed significantly to the risk estimates. However, the analyses indicate that the excavation conducted as an Interim Remedial Measure (IRM) effectively eliminated these contaminants as a concern.

There is some suggestion of a spatial relationship between indicators of stress and the Ciba facility; 10-day sediment bioassays using *Chironomus tentans* resulted in the average survival rates of 79 percent in the reference sediment, 67 percent in the Upstream Reach, 18 percent in the facility reach, and 29 percent in the Downstream Reach. However, the interpretation of the spatial pattern in the bioassay results is complicated by the geomorphological and hydraulic characteristics of the Pawtuxet River. A depositional zone in the lower 2.8 km section of the river begins approximately 0.5 km upstream of Ciba's former Production Area (HydroQual, 1996). The four kilometer section of the Upstream Reach, from Cranston (km 6.8) to just upstream of the Upper Facility Reach, has a steeper bed slope and as a result little deposition occurs. As the bed slope decreases just upstream of the Upper Facility reach, deposition begins to occur, mostly to the sides of the deeper center channel. This feature makes it difficult to relate gradients in chemical concentration in the sediment bioassay results to specific sources. Chemicals sorbed to water column solids will tend to be deposited in the lower portion of the river, regardless of whether they enter the river upstream of Cranston or in the lower 2.8 km. Similarly, particulate organic material (such as nutrients and other high BOD materials) that can result in ammonia production may be deposited from upstream sources. The ammonia could account for some of the toxicity observed in the bioassays.

The ecological risk assessment has involved the interpretation of biological observations within the river estimation of the ecological risk posed by contaminants present in the sediment and water. These analyses indicate that the ecosystem of the Pawtuxet River is stressed and that contaminants are a probable causative factor. Further, the analyses indicate that discharges from the Ciba facility contribute little to the observed stresses. Rather, the contaminants (PAHs, Metals, and Pesticides) contributing significantly to risk are ubiquitous within the study area and are those typical of urban and industrial areas.

Tables

**Table E-1. Effect of Remedial Actions on
Contaminant Concentrations in Sediments Adjacent
to the Ciba Production Area over 10.6 Year
Projection**

| Chemical | Effective Action | Concentration at Production Area (mg/kg) | |
|---------------|------------------------|--|---------------------|
| | | Initial | Final |
| Chlorobenzene | Groundwater Capture | 3700 | 0.06 ⁽¹⁾ |
| Naphthalene | Groundwater Capture | 150 | 0.05 ⁽²⁾ |
| PCBs | Excavation | 66 | 1.6 |
| Tinuvin 328 | Excavation | 640 | 0.3 |
| Zinc | Excavation | 2800 | 330 |

Note:

¹ Achieved after 2 years

² Achieved after 3 years

**Table ES-2
Summary of Estimated Risks***

| TOXICITY QUOTIENTS FOR BENTHIC INVERTEBRATES | | | | | |
|--|----------|-------------------|------------------|----------------|------------|
| Chemical Class | Upstream | Upper Facility | | Lower Facility | Downstream |
| | | Before Excavation | After Excavation | | |
| Metals | 2.6 | 4.4 | 2.4 | 4.5 | 4.5 |
| PAHs | 77.1 | 33.6 | 22.9 | 103.0 | 79.6 |
| PCBs/Dioxins/Furans | 0.0 | 4.2 | 0.0 | 0.2 | 0.1 |
| Organochlorine Pesticides | 7.3 | 6.4 | 2.6 | 36.6 | 10.2 |
| Organophosphorus Pesticides | 0.0 | 0.0 | 0.0 | 26.2 | 0.0 |
| VOCs | 0.4 | 6.8 | 0.2 | 0.0 | 0.1 |
| Phenols | 4.2 | 4.5 | 1.0 | 1.6 | 78.2 |
| 4-Chloroaniline | 0.3 | 12.9 | 0.0 | 0.0 | 0.0 |
| Other | 0.1 | 0.7 | 0.6 | 0.3 | 0.2 |
| Ecological Toxicity Index | 92 | 74 | 30 | 173 | 173 |

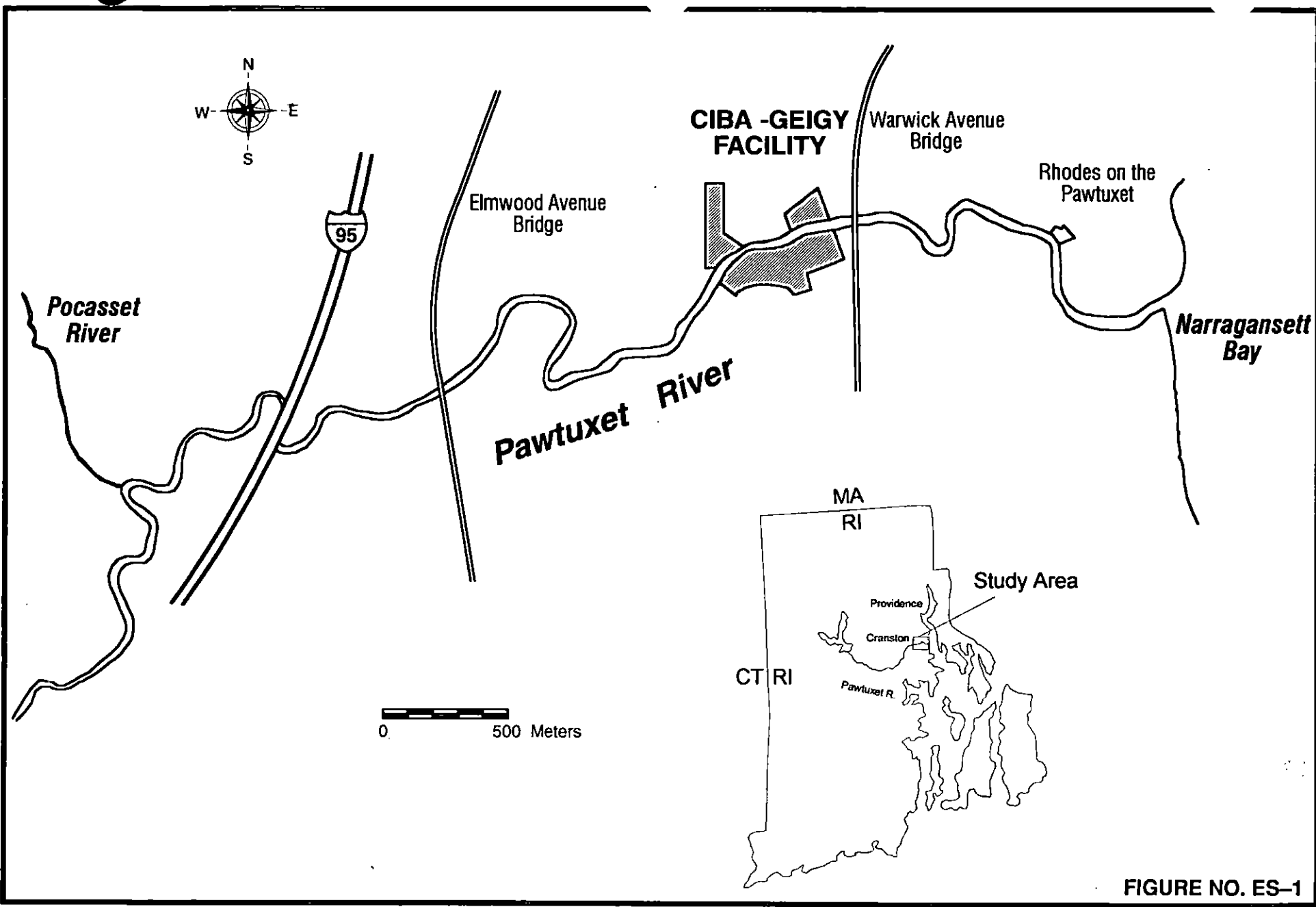
| TOXICITY QUOTIENTS FOR FISH | | | | | |
|-----------------------------|----------|------------------|------------------|----------------|------------|
| Chemical Class | Upstream | Upper Facility | | Lower Facility | Downstream |
| | | Before Excavatio | After Excavation | | |
| Metals | 10.1 | 5.9 | 5.9 | 7.7 | 7.0 |
| Other | 0.0 | 0.0 | 0.0 | 0.5 | 0.3 |
| Ecological Toxicity Index | 10 | 6 | 6 | 8 | 7 |

| TOXICITY QUOTIENTS FOR RACCOON | | | | | |
|--------------------------------|----------|-------------------|------------------|----------------|------------|
| Chemical Class | Upstream | Upper Facility | | Lower Facility | Downstream |
| | | Before Excavation | After Excavation | | |
| Metals | 3.6 | 2.7 | 1.7 | 6.3 | 4.2 |
| PCBs/Dioxins/Furans | 0.0 | 51.4 | 0.0 | 1.8 | 0.9 |
| Other | 0.4 | 0.6 | 0.1 | 0.7 | 0.8 |
| Ecological Toxicity Index | 4 | 55 | 2 | 9 | 6 |

| TOXICITY QUOTIENTS FOR HERON | | |
|------------------------------|-------------------|------------------|
| Chemical Class | River-Wide Total | |
| | Before Excavation | After Excavation |
| Metals | 7.3 | 7.2 |
| PCBs/Dioxins/Furans | 1.1 | 0.2 |
| Organochlorine Pesticides | 3.2 | 3.1 |
| Other | 1.2 | 1.2 |
| Ecological Toxicity Index | 13 | 12 |

* Includes the chemical classes accounting for >90% of the Ecological Toxicity Index of one or more river reaches.

Figure



INTRODUCTION

1.1 OVERVIEW

CIBA-GEIGY Corporation (Ciba) and the United States Environmental Protection Agency (USEPA) entered into an Administrative Order on Consent (Order) in June 1989 to perform a RCRA Corrective Action Study at the Ciba facility in Cranston, Rhode Island (the Site). A RCRA Corrective Action Study consists of four stages (Section 1.2.1). The RCRA Facility Investigation (RFI) is the second stage of the Corrective Action Study. As agreed with USEPA, the RFI was performed into two parts - the *On-Site RFI* and the *Pawtuxet River RFI*. The RFI report for On-Site areas was submitted to USEPA on July 31, 1995. This RCRA Facility Investigation Report for the Pawtuxet River presents the results of the Pawtuxet River RFI.

This section reviews the history of the project and the Site, summarizes the objectives of the River RFI and provides the organization of the rest of this document.

1.2 BACKGROUND

This section reviews the history of the project and the history of the Site. Detailed information on the project and site history were provided in Chapter 1 of the Current Assessment Summary Report and in the RCRA Facility Investigation Report On-Site Areas. Figure 1-1 presents a flow chart which summarizes the project history.

1.2.1 Project History

An Administrative Order on Consent (Order) requiring a RCRA Corrective Action Study at the Site was signed by Ciba on June 9, 1989 and became effective on June 16, 1989. A RCRA Corrective Action Study has four stages. The chronology of project activities associated with each of these stages is outlined below.

Stage 1: RCRA Facility Assessment. In 1987, the USEPA conducted a RCRA Facility Assessment (RFA) to identify known and/or suspected releases at the Site. The results were presented in the Final RFA Report CIBA-GEIGY RCRA Facility Assessment (January 1988). In 1988, Ciba conducted a Preliminary Investigation (not required by the Order) to begin characterizing the Site and selected releases. The results of the Preliminary Investigation were summarized in Chapter 1 of the Current Assessment Summary Report.

Stage 2: RCRA Facility Investigation. The RCRA Facility Investigation (RFI) was conducted to characterize the impact of known and/or suspected releases that were determined by the RFA to require further action. The RFI was conducted in two phases; Ciba proposed that Phase I be conducted in two parts - Phases IA and IB - to obtain additional guidance from the USEPA throughout the project. Phase IA was conducted in late 1989 and mid-1990 to characterize the Site's physical environment more completely. The results of the Phase IA studies were presented in the Phase IA Report (approved in June 1991). Phase IB was conducted in late 1990 and early 1991; it characterized known and/or suspected releases at the Site more completely and also provided additional information about the Site's physical environment. In Phase IB, two rounds of sampling were performed. The results of Phase IA and IB were presented in the Phase I Interim Report (submitted in November 1991). The Phase II investigation began after USEPA approved the Phase I Interim Report and Phase II Proposal. Work performed during Phase II included: performing additional site characterization studies, refining the conceptual Site model, conducting additional sampling, performing the public health and environmental health risk evaluation (PHERE), and developing Media Protection Standards (MPS). The results of Phases I and II were presented in the RCRA Facility Investigation Report On-Site Areas submitted to USEPA on July 29, 1995.

After submitting the Phase I Interim Report and Phase II Proposal, the Phase II investigation of the Pawtuxet River was moved onto a separate scheduling track from the other Phase II work. The Phase II Pawtuxet River Investigation began after USEPA approved the Phase II Pawtuxet River Proposal (approved April 15, 1994). The Phase II investigation entailed additional studies to characterize the river's physical environment, additional sampling of sediment for physical characteristics and selected contaminants, developing a hydrodynamic, sediment transport, and a contaminant fate and transport model, performing the baseline ecological risk assessment and

developing MPS. The results of Phases I and II are presented in this Pawtuxet River RFI Report.

Stage 3: Corrective Measures Study Proposal: The Corrective Measures Study Proposal (CMS Proposal) describes the measures that are available to achieve the MPS proposed for this investigation. As agreed with USEPA, the requirement for developing a CMS Proposal was waived for this investigation.

Stage 4: Corrective Measures Study Report: The Corrective Measures Study Report (CMS Report) evaluates the technologies that are available to achieve the MPS. This report will be submitted as two separate documents. The On-Site CMS Report was submitted in September 1995. It focused on those technologies that were identified and evaluated to achieve the MPS proposed for hotspots of PCB-contaminated soil found on-site. Technologies to meet the MPS proposed for other media of concern (specifically groundwater, surface water, and sediment in the Pawtuxet River) will be addressed in the Pawtuxet River CMS Report. This report is scheduled to be submitted in June 1996.

Interim Remedial Measures

In addition to these four stages of the RCRA Corrective Action Study, three Interim Remedial Measures (IRMs) have also been implemented at the Site. These IRMs are described below.

Stabilization Investigation

Stabilization activities included the design, construction, and operation of a groundwater capture system, a groundwater pretreatment system, and a soil vapor extraction system. The stabilization investigation was integrated into the RCRA Facility Investigation (RFI) through a Modification of the Order executed on September 28, 1992. The Stabilization Work Plan was submitted to the USEPA in September 1992; conditional approval of the Work Plan was granted on December 21, 1992. The Stabilization Investigation Report and Design Concepts Proposal was submitted to the USEPA in May 1993. The Draft Stabilization Design Documents were submitted to the USEPA in November 1993. The Final Stabilization

Design Documents were submitted to the USEPA in June 1994 and approved on September 27, 1994. These final design documents were revised and resubmitted on January 30, 1995 because of changes to the groundwater pretreatment system. Startup of the groundwater capture and groundwater pretreatment began in September 1995; startup of the soil vapor extraction system began in April 1996.

Excavation and Disposal of PCB-Contaminated Soil

A voluntary IRM to excavate and dispose of PCB-contaminated soil was performed at the Site from June through September 1995. Prior to conducting this activity, an IRM Work Plan (On-Site Interim Remedial Measures Work Plan) was submitted to USEPA on March 13, 1995. The IRM Work Plan addressed excavating and disposing of PCB-contaminated soils from hotspots within the Production Area and Warwick Area (SWMU-5), and also addressed excavating and disposing of a zinc oxide/soil pile (SWMU-6). After submitting the IRM Work Plan in March, 1995, Ciba received and responded to comments generated by USEPA and RIDEM. These issues were addressed satisfactorily with both agencies. RIDEM approved the Work Plan as an Interim Remedial Measure in a letter dated June 12, 1995. USEPA had no further comments and was not required to approve the voluntary IRM under RCRA regulations.

The results of the IRM were presented in Section 6 of the On-Site CMS Report submitted to USEPA in September 1995. A final detailed report (On-Site Soil Interim Remedial Measures Report) which included all final validated data and results not included in the On-Site CMS Report was submitted to USEPA and RIDEM in March 1996.

Dredging and Disposal of Impacted Sediments in the Former Cofferdam Area

Another voluntary IRM to dredge, stabilize, and dispose of sediments from the Former Cofferdam Area was completed in the Fall of 1995. An IRM Work Plan was prepared and submitted to RIDEM and USEPA on April 28, 1995. This Work Plan was reviewed by USEPA, RIDEM, and the Army Corps of Engineers (ACOE), and comments generated by these agencies are addressed in the Work Plan. A final detailed report on the sediment removed will be submitted in April 1996.

1.2.2 Site History

Beginning in 1930, the Alrose Chemical Company manufactured chemicals at the Site. The GEIGY Chemical Company of New York purchased the Site in 1954 and merged with the Ciba Corporation in 1970; thereafter, the Site was used for batch manufacturing of organic chemicals. Over time, the following major product categories were manufactured:

- 1950s - agricultural products, as well as, leather and textile auxiliaries;
- 1960s - plastics additives, optical brighteners, pharmaceuticals and textile auxiliaries;
- 1970s - agricultural products, plastics additives, pharmaceuticals, textile auxiliaries and bacteriostats; and
- 1980s - plastics additives and pharmaceuticals.

By May 1986, Ciba had ceased all chemical manufacturing operations at the Site and had begun decommissioning and razing the plant. The Site has been divided into three study areas: the Production Area, the Warwick Area, and the Waste Water Treatment Area. The boundaries of these three areas are shown on Figure 1-2. The Pawtuxet River runs through the Site as shown on Figure 1-2.

SWMUs, AOCs, and AAOIs

Twelve solid waste management units (SWMUs) and two areas of concern (AOCs) were identified in the Order. For completeness of the study, Ciba identified two additional areas of investigation (AAOIs). Information about these SWMUs, AOCs, and AAOIs is summarized in Table 1-1. Additional details about these SWMUs, AOCs, and AAOIs (and past known and/or suspected releases) are presented in Section 3.0 of this report.

1.3 OBJECTIVES OF THE PAWTUXET RIVER RFI

The Pawtuxet River RFI consisted of five tasks: the physical characterization, source characterization, release characterization, river modeling (hydrodynamic, sediment transport, and fate and transport of contaminants), and a ecological risk assessment. The specific objectives of these tasks are discussed below.

1.3.1 Physical Characterization

The main objective of the physical characterization was to describe the hydrology of the Pawtuxet River. Physical and chemical attributes of the river water and sediment were characterized. The physical characterization of the river was completed during two phases: Phases I and II. The specific tasks completed in each phase of the physical characterization of the river were accomplished at different times, but in general, Phase I activities were completed from July 1990 through March of 1991 and Phase II activities were completed from 1992 through 1994. The results of the physical characterization are presented in Section 2.0 of this report.

1.3.2 Source Characterization

During the On-Site RFI, the Solid Waste Management Units (SWMUs), Areas of Concern (AOCs) and Additional Areas of Investigation (AAOIs) were studied to characterize the wastes contained at these locations and evaluate their potential for release of contamination into the environment. The results of the on-site source characterization are summarized in Section 3.0 of this report with more emphasis on potential sources which may have impacted the river.

1.3.3 Release Characterization

The objective of the release characterization was to define the spatial distribution of potential contaminants in river water and sediments. Samples were collected from transects located upstream, adjacent to and downstream of the Site during two rounds of sampling within each of the two phases of this study. Water and sediment quality were compared between upstream,

facility and downstream reaches of the river. The results of the release characterization are presented in Section 4.0 of this report.

1.3.4 River Modeling

The objective of river modeling was to provide a quantitative basis for evaluating the effects of various remediation alternatives on contaminant levels in the Pawtuxet River. This modeling effort included collecting water column and sediment contaminant data and developing a mathematical modeling framework to evaluate the path and transport of contaminants in the river. A summary of the river modeling investigation is presented in Section 5.0 of this volume. The complete results of this study are presented in Volume II.

1.3.5 Ecological Risk Assessment

The main objective of the ecological risk assessment was to provide a baseline evaluation of the potential threat posed to aquatic and terrestrial receptors by chemicals contained in river surface waters and surface sediments (0 - 0.5 feet) in the Pawtuxet River adjacent to the Site. A detailed summary of the ecological risk assessment is presented in Section 6.0 of this volume. The complete results of this assessment is presented in Volume III.

1.4 REPORT ORGANIZATION

This Pawtuxet River RFI Report is presented in three volumes.

Volume I

Executive Summary

Section 1 Introduction

Section 2 Results of the physical characterization of the Pawtuxet River

Section 3 Results of the on-site RFI pertaining to identification of potential sources of contamination to the river

Section 4 Results of the release characterization

| | |
|-------------------|--|
| Section 5 | Summary of Pawtuxet River modeling investigation |
| Section 6 | Summary of the aquatic baseline ecological risk assessment |
| Section 7 | Summary and Conclusions of the RFI |
| Section 8 | References |
| Appendix A | Sediment probing report |

Volume 2

Presents the results of the modeling that was performed for the Pawtuxet River..

Volume 3

Presents the baseline ecological risk assessment.

Table

TABLE 1-1
SWMUs, AOCs, AND AAOIs

| <u>Number</u> | <u>Name</u> | <u>Study Area</u> | <u>Active Dates</u> | <u>Description</u> |
|---------------|---|-------------------|---------------------|--|
| SWMU-1 | Hazardous Waste Storage Area | Warwick | 1981 to 1986 | SWMU-1 was designed for a maximum capacity of 768 55-gallon drums. Typically, it stored 300 to 400 drums containing various wastes including flammable liquids and solids, corrosive liquids and solids, organic mixtures and solids, non-hazardous organic mixtures, and chloroform. The area was about 42 by 58 feet, and was asphalt-lined, diked, and surrounded by a 6-foot chain-link fence. The dike was capable of holding 48,000 gallons. |
| SWMU-2 | 6000-Gallon Hazardous Waste Storage Tank | Production | 1981 to 1986 | SWMU-2 was a carbon steel tank used to store process wastes containing acetone, toluene, monochlorobenzene, isopropanol, naphtha, xylene, heptane, methanol, and water. The tank was 17 feet high, 8 feet in diameter, and was enclosed by an 8000-gallon capacity dike (14.5 by 19 by 4 feet). |
| SMU-3 | 7500-Gallon 90-Day Storage Tank | Production | 1985 to 1986 | SWMU-3 was a vertical above-ground tank used to store flammable liquids for periods of less than 90 days. The stainless steel tank was 17 feet high, 8.5 feet in diameter, and was enclosed by a 25,000-gallon dike (about 28 by 29 by 4 feet). |
| SWMU-4 | Trash Compactor Station | Production | 1972 to 1986 | SWMU-4 had two trash compactors (30- and 55-cubic yard capacity) and only handled packaging material, paper wastes, and washed fiber drums. The trash compactor station (21 by 36 feet) was concrete-lined and drained to the Waste Water Treatment Plant. |
| SWMU-5 | River Sediment Storage Area | Warwick | 1971 to 1976 | SWMU-5 contained about 6630 cubic yards of sediment that had been dredged from the Pawtuxet River as part of removing the original cofferdam/waste water outfall. The sediment was removed from the Site in 1976; the area's natural grade was restored in 1977. |
| SWMU-6 | Zinc Oxide/Soil Storage Pile | Warwick | Late 1960s to 1995 | SWMU-6 had about 25 cubic yards of soil containing about 10% zinc oxide residue; the residue resulted from a broken railcar spill. The soil pile was about 50 feet long by 7 feet wide by 2 feet high. |
| SWMU-7 | Chlorosulfonic Acid Release Area | Production | 1961 | SWMU-7 was an area about 10 by 20 feet in which about 500 gallons of chlorosulfonic acid were released. |
| SWMU-8 | Prussian Blue Release Area | Production | 1956 | SWMU-8 was an area where about 300 cubic yards of blue-stained soil (believed to be stained by the release of an unknown quantity of Prussian Blue) was excavated and removed. |
| SWMU-9 | Waste Water Pipeline Break - Warwick Area | Warwick | 12 Jan. 1982 | SWMU-9 is where a break in the main raw waste transfer line resulted in the discharge of about 24,000 gallons of waste water. The waste water entered the surface water runoff catchment system and discharged to the Pawtuxet River. The waste water typically contained halogenated and non-halogenated solvents and other organic compounds routinely used in the chemical manufacturing process. |

| <u>Number</u> | <u>Name</u> | <u>Study Area</u> | <u>Active Dates</u> | <u>Description</u> |
|----------------------|---|---------------------------------|---------------------|--|
| SWMU-10 | Waste Water Pipeline Break - Waste Water Treatment Area | Waste Water Treatment | 7 Sept. 1983 | SWMU-10 is where a break in an underground waste water line resulted in a discharge of about 50,000 gallons. The discharge flowed into a small pond on-site and then diverted to the Pawtuxet River. The pH of the released waste water was 8.5; the chemical oxygen demand was 1010 parts per million. This discharge contained acetone (31 pounds), isopropyl alcohol (45 pounds), toluene (7 pounds), xylene (1.7 pounds), zinc (0.25 pounds), and nitrobenzene (0.125 pounds). |
| SWMU-11 | Toluene Waste Water Release Area | Production | 1983 | SWMU-11 is where an estimated release of between 9 and 90 pounds of toluene in waste water occurred via a subsurface sump associated with Building 11. |
| SWMU-12 | Waste Water Treatment Plant | Waste Water Treatment | 1970 to 1983 | SWMU-12 is the area formerly occupied by the Waste Water Treatment Plant. Biological trickling towers were used and periodic sump overflows from these towers resulted in discharges to the river. Influent to the towers routinely contained volatile and semi-volatile organic compounds. Additional releases from SWMU-12 in excess of the NPDES permit requirements have been reported for zinc, BOD, and phenols; in two releases, chloroform was discharged to the river. |
| AOC-13 | Process Building Area | Production | 1930 to 1986 | Area in which most of the production activities occurred. |
| AOC-14 | Atlantic Tubing and Rubber Company Property | Adjacent and west of Production | 1981 to present | This property was never used or developed by Ciba. |
| AAOI-15 ¹ | Laboratory Building Waste Water Sump | Production | 1961 to 1987 | The sump functioned as part of normal operations in the Laboratory Building. The gravity sump drained to sewer lines that discharged to the publicly owned treatment works. |
| SWMU-16 ² | Maintenance Department Cleaning Area | Warwick | mid-1960s to 1986 | Area where maintenance equipment was steam-cleaned. Rinse water drained to a nearby surface water catch basin. |

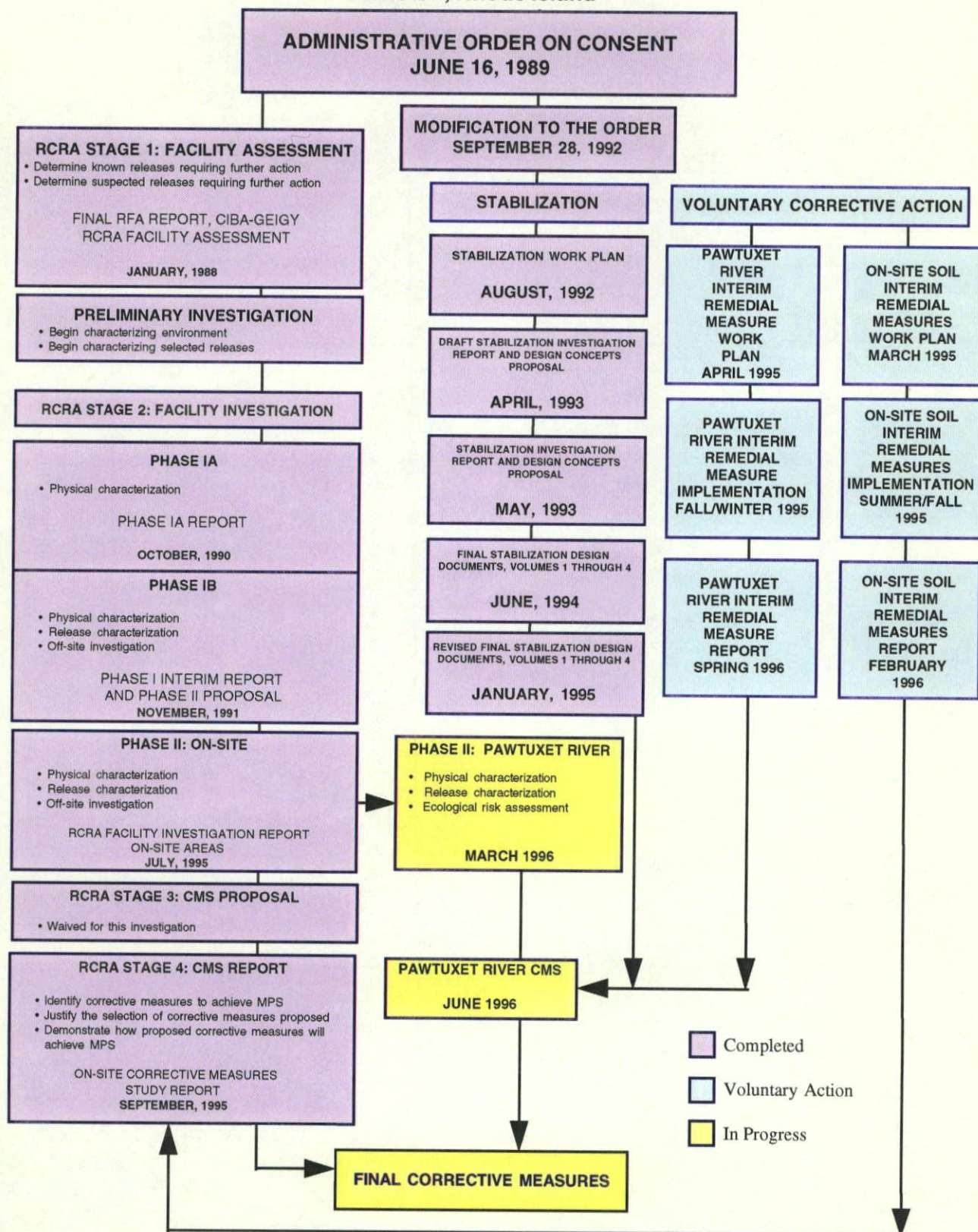
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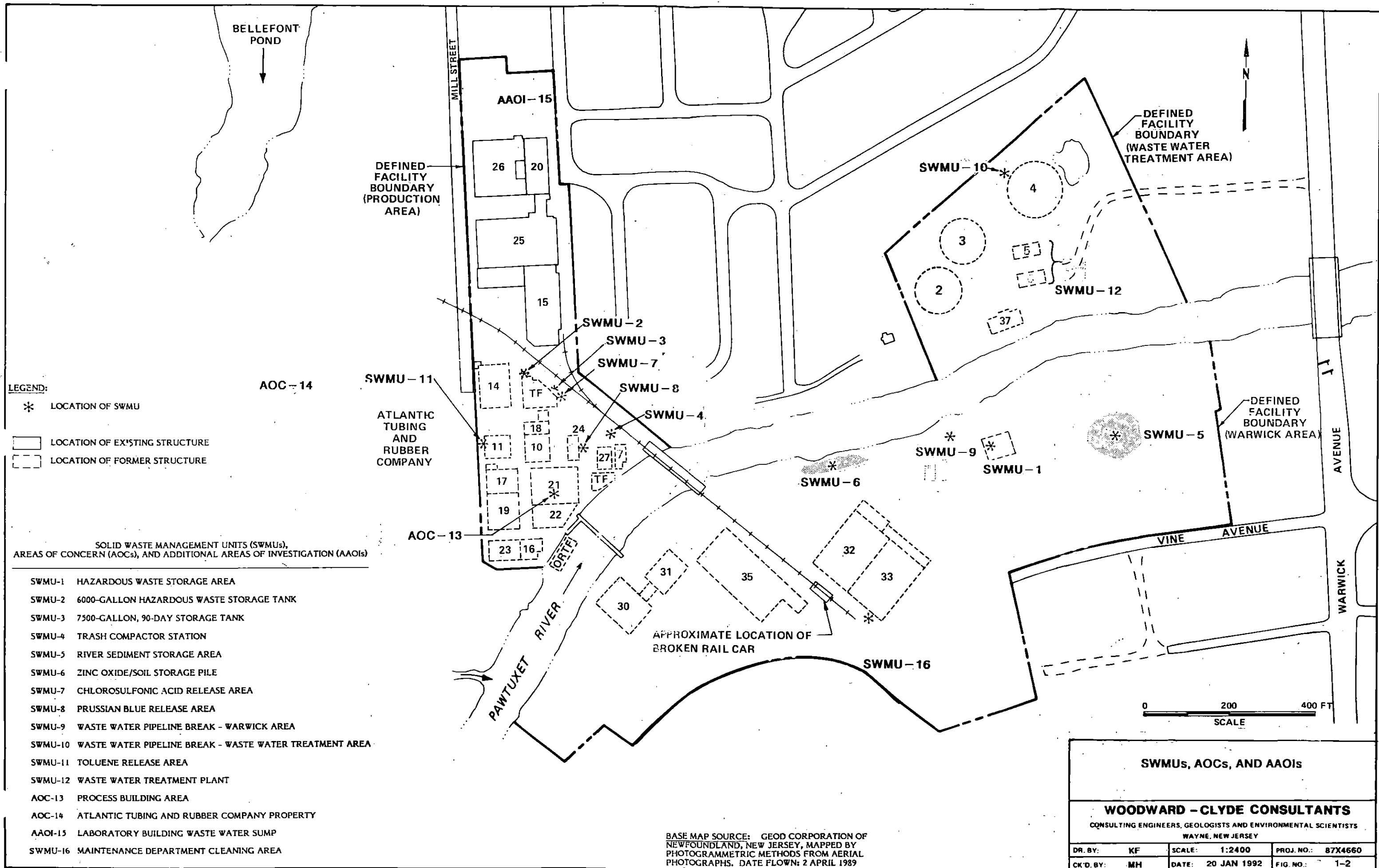
1. Ciba identified the two additional areas of investigation (AAOIs); no releases are known, but the potential for a release existed in the past.
2. Originally identified as AAOI-16 and redesignated as SWMU-16 following the Phase I investigation.

Figures

Figure 1-1

**RCRA Corrective Action Process
Ciba-Geigy Corporation Facility
Cranston, Rhode Island**





PHYSICAL CHARACTERIZATION

2.1 OVERVIEW

One of the primary tasks conducted during the RCRA Facility Investigation (RFI) hydrological investigation of the Pawtuxet River was the physical characterization. The goal of the physical characterization was to evaluate the physical and chemical characteristics of the river.

This section presents the objectives, methods and analyses, and results of the physical characterization (including stratification, literature review, flow characterization studies, evaluation of river bathymetry, measurement of sediment physical characteristics and development of hydrodynamic and sediment transport models for the Pawtuxet River).

2.2 OBJECTIVES

The specific objectives of the Phase I physical characterization were to:

- describe the location, elevation, depth, width, flow rates, seasonal variation, flood potential, and Rhode Island state classification of the Pawtuxet River along the facility reach;
- describe the on-site drainage patterns;
- locate and describe potential areas of riverbed sediment deposition;
- evaluate the riverbed sediment thickness profiles; and
- characterize the physical properties of riverbed sediments using grain size distribution, bulk density, cation exchange capacity, pH, porosity, and total organic carbon content.

The specific objectives of the Phase II physical characterization were designed to fill data gaps identified during Phase I by:

- developing a bathymetric map of water depths spanning upstream, facility, and downstream reaches;
- quantifying physical characteristics of sediments in the mapped areas (including sediment thickness);

- measuring stage height in the Facility Reach and at the Pawtuxet Cove Dam for three flow regimes;
- developing a hydrodynamic model of the river system; and
- developing a sediment transport model of the river system.

2.3 REGIONAL AND LOCAL HYDROLOGY

This section summarizes information gathered during the literature review and presented in previous submittals to provide an overview of the regional and local hydrologic setting.

2.3.1 Description of Site and Drainage Area

The Site is located in Cranston and Warwick, Rhode Island in the mid-eastern portion of the state as shown on Figure 2-1. The 31 acre Site is adjacent to the Pawtuxet River which drains through Pawtuxet Cove into the Providence River and ultimately into Narragansett Bay. The Site borders the northern and southern boundaries of the river, between Interstate 95 and Alternate Route 1. Approximately 13 acres of the facility are located north of the Pawtuxet River in Cranston and about 18 acres lie south of the river in Warwick. The Site is located in Providence and Kent counties.

The Site is bordered to the north and south by residential areas, to the east by commercial areas and to the west by both an open space area (formerly the property of the Atlantic Tubing and Rubber Company) and a mixed industrial area. This mixed industrial area had been used by Atlantic Tubing and Rubber Company for manufacturing rubber and plastic.

Located in the coastal plain, the topography of the area is level to gently sloping, with slopes ranging from 0 to 5 percent. The facility elevation ranges from about 10 to 25 feet above mean sea level. The Pawtuxet River flows from west to east through the Site. Throughout the study area, the river lies within the 10 foot mean sea level (MSL) contour. Some sections of the Site are within the 100-year flood plain.

The Site is located in the Narragansett Bay drainage basin. The 1,850 square mile drainage basin lies within Rhode Island and Massachusetts and includes the system of waterways that discharge into the Atlantic Ocean between Point Judith in Narragansett and Sakonnet Point in Little Compton

(SCS, 1981).

The Pawtuxet River Basin (Figure 2-2), located within the Narragansett Bay drainage basin, is about 230 square miles in area. Flow in the river is regulated by the Scituate Reservoir Dam, the Flat Rock Reservoir Dam, the Pawtuxet Cove Dam and multiple small mill dams located along the river.

The 11.7 mile long main stem of the Pawtuxet River is formed near River Point in West Warwick by the confluence of the north branch and south branch of the Pawtuxet River. The north branch originates at the outlet of the Scituate Reservoir and flows in a southeasterly direction for about 6 miles to the confluence with the south branch. The Scituate Reservoir is a water supply reservoir owned and operated by the City of Providence. The south branch originates at the outlet of the Flat River Reservoir. The south branch flows 9 miles through Coventry and West Warwick before joining the north branch near River Point.

The western portion of the drainage basin is relatively undeveloped. However, the lower reaches of both branches, and especially the main stem of the Pawtuxet River, flow through highly developed residential, industrial and commercial areas.

2.3.2 Major Tributaries and Surface Water Bodies

The major surface water bodies located near the Site are Bellefont Pond, Fenner Pond, Pleasure Lake, Edgewood Lake and Elmwood Lake. Bellefont Pond is located northwest of the Site. The pond drains through culverts to the south and enters the Pawtuxet River from the north about 300 feet upstream of the Production Area. The pond is classified by the U.S. Fish and Wildlife Service as an open water palustrine system or marsh with standing water. Bellefont Pond has a surface water elevation between 10 and 20 feet above MSL.

Fenner Pond is located to the northwest of the facility, about 1,500 feet northwest of Bellefont Pond. Fenner Pond has a surface water elevation of about 23 feet above MSL.

Pleasure Lake, Edgewood Lake and Elmwood Lake are interconnected lakes located in Roger Williams Park north of the site. These lakes have a surface water elevation of 29 feet above MSL.

The Pocasset River flows into the Pawtuxet River about 2.5 miles upstream of the facility. Water from Randall Pond, Dyer Pond, Print Works Pond and Blackamore Pond drains into the Pocasset River prior to its confluence with the Pawtuxet.

The surface water elevation of the Pawtuxet River in the study area has ranged from about 6 feet above MSL to about 11.5 feet above MSL during July 1992 through January 1993. In Phase IA, the river elevation ranged from 6.5 to 7.5 feet above MSL. The river is hydraulically downgradient from all of the major surface water bodies located near the site.

2.3.3 River Classification and Use

The Pawtuxet River has been divided into sections according to water quality standards and classifications established by the Rhode Island Department of Environmental Management. The sections may be classified as freshwater Class A, B, C, D or E. Class A waters are suitable for drinking water supply and all other water uses. Class B waters are suitable for public water supply with appropriate treatment, for agricultural uses, for bathing and other primary contact recreational activities and for fish and wildlife habitat. Class C waters are suitable for boating and other secondary contact recreational activities, for fish and wildlife habitat and for industrial processes and cooling. Class D waters are suitable for the migration of fish and have good aesthetic value. Class E denotes nuisance conditions and use is limited to certain industrial processes, cooling, power generation and navigation. Classes D and E are used merely to describe existing conditions and are not considered an acceptable goal for the management of any water course.

The main stem of the Pawtuxet River flows through highly developed residential, industrial and commercial areas. Above the Cranston Sewage Treatment Plant, the Pawtuxet River is classified as Class C. Below the Cranston Sewage Treatment Plant and within the Facility Reach, the river is classified as "Class D" by RIDEM.

2.3.4 Flow Regimes

The Pawtuxet River is a fourth order stream that drains the largest drainage basin in Rhode Island (Metcalf & Eddy, 1983). The USGS Cranston gauge is located three river-miles upstream of the facility. The gauge has a period of record from 1941 to 1985. The monthly average discharge for the river at the USGS Cranston gauge ranged from 75 cubic feet per second (cfs) to 1788 cfs. The

one-year-in-ten average seven-day low flow (7Q-10) at the Cranston gauge is 74 cfs, which is equivalent to about 48 million gallons per day (mgd). During the period from 1978 through 1988, the USGS measured flow instantaneously 128 times at the Cranston gauge and 97 times at the Warwick Avenue Bridge. The mean instantaneous flow at these two locations was 341.6 and 431.9 cfs, respectively (USGS, 1990). The portion of the Pawtuxet River basin contributing flow to the Cranston gauge is about 200 square miles. Flow in the river is regulated by the two reservoir dams located at the upstream reaches of the north and south branches, the Pawtuxet Cove Dam and multiple small dams located throughout the river.

2.3.5 General Water Quality

The USGS monitored water quality at two locations in the Pawtuxet River over a ten year period, from 1978 - 1988. Samples were collected at the Cranston gauge and at the Warwick Avenue bridge, just downstream of the facility. This information was used to summarize the general water quality of the river in the vicinity of the Site as presented in Table 2-1.

The general water quality of the Pawtuxet River near the Site is greatly influenced by the three wastewater treatment plants located upstream of the facility, as shown by the elevated concentrations of nitrogen and phosphorus in the water column. In addition, the organic carbon content and the chemical and biological oxygen demand (BOD) of the river water are higher and the dissolved oxygen concentrations are lower than in other similar streams in the region, in general.

River water in this region is soft, with lower concentrations of calcium and magnesium than in other regions of the U.S. Likewise, the alkalinity, or buffering capacity, of the rivers in this region is lower than the 20 mg/l or higher level recommended by USEPA (1986). The mean pH of the Pawtuxet River water is on the low end of the USEPA water quality criterion of 6.5 to 9.0 to be protective of aquatic life.

During the USGS study, maximum trace element concentrations which potentially exceed acute aquatic-life protection criteria were measured at the Cranston and Warwick Avenue sites, for cadmium, chromium, copper, lead and silver (USGS, 1990).

2.4 METHODS AND ANALYSES

Detailed descriptions of the methods and analyses used to satisfy the objectives listed in Section 2.2 were presented previously in the Phase II Pawtuxet River Proposal (CIBA-GEIGY, 1992). An integrated overview of the methods used during both Phases is presented in the following sections.

2.4.1. River Stratification

During the hydrological investigation of the Pawtuxet River, the river was stratified into four segments or reaches. Stratification is a sampling technique that is used to improve the precision of estimates by recognizing that measurements may be quite different in different identifiable segments of the area being sampled (USEPA, 1985). The four reaches are shown in Figure 2-3 and are defined as follows:

- 1) The *Upstream Reach*: this segment of the river extends from the meander bend at Elmwood Avenue to the upstream border of the Site;
- 2) The *Upper Facility Reach*: this segment of the river extends from the upstream boundary of the Site downstream about 600 feet to the downstream boundary of the Production Area at the Railroad Bridge;
- 3) The *Lower Facility Reach*: this segment of the river extends from the downstream boundary of the Production Area downstream about 1,200 feet to the downstream boundary of the Site; and
- 4) The *Downstream Reach*: this segment of the river extends from the downstream boundary of the Site to a meander bend near Rhodes on the Pawtuxet.

2.4.2. Literature Review

A thorough review of pertinent literature was conducted by examining Ciba's files, the Soil Survey of Rhode Island (USDA SCS, 1981) and publications of the United States Geological Survey (USGS). The Ciba files provided specific information on the Site and results of previous studies of

the area. The soil survey was used to provide background on the drainage area, soil types and adjacent environs. The USGS publications provided discharge data, flow statistics and general water quality data for the Pawtuxet River.

2.4.3 Flow Characterization Methods

River flow characterization methods conducted during Phases I and II included: reviewing USGS data for the river, conducting a water discharge survey, monitoring suspended sediment discharge, and measuring river stage height during different flow regimes.

The water discharge survey was completed by measuring flow with a flow meter along two transects during three different flow conditions. The two transects were located at the upstream and downstream ends of the facility reach. Discharge was calculated using the USGS mid-section method (USGS, 1977). The results are presented in the Phase II Pawtuxet River Proposal (CIBA-GEIGY, 1992).

Suspended sediment discharge monitoring was performed by collecting depth-integrated water samples concurrently with water discharge monitoring. Water samples were analyzed for total suspended solids (TSS). The TSS concentrations were converted to suspended sediment discharge using the water discharge data). The results are presented in the Phase II Pawtuxet River Proposal (CIBA-GEIGY, 1992).

The river stage height was measured in the facility reach and at Pawtuxet Cove Dam using pressure transducers equipped with data loggers. Stage height data were collected under low, medium and high flow regimes). The results are presented in Volume II of this Pawtuxet River RFI (CIBA-GEIGY, 1996).

2.4.4 River Bathymetry Characterization Methods

Three methods were used to develop the bathymetric maps of the Pawtuxet River: manual measurement of water depth, measurement of water depth with a fathometer and a hip chain and automated water depth measurement using a fully automated azimuth surveying system in conjunction with a precision depth echosounder. The automated surveying system was used in the lower sections of the river where clear line-of-sight was available from the onshore control points

and where river depth was sufficient to operate the boat-mounted echosounder. For the upstream sections of the river, water depth was measured using manual measurement techniques in conjunction with conventional surveying technology to verify measurement location. The Phase I bathymetric survey of the facility reach was conducted using a fathometer and hip chain, except in areas where aquatic macrophytes prohibited use of the fathometer. In these areas, water depth was measured manually. The facility reach was re-surveyed during Phase II using the automated surveying technology. Details of all methods used are provided in the Phase II Pawtuxet River Proposal (CIBA-GEIGY, 1992).

2.4.5 Sediment Physical Characterization Methods

The physical characteristics of the sediments were measured during Phases I and II of the RFI. During Phase I, the sediment was analyzed for total organic carbon (TOC), grain size, pH and cation exchange capacity (CEC). Where undisturbed cores could be collected, the sediment also was analyzed for porosity and bulk density.

During Phase II of the RFI, an extensive physical characterization of the sediment was performed to quantify sediment thickness, TOC content and grain size. Undisturbed cores for bulk density measurement were collected where possible. The sediment depth was measured by manually inserting a probe into the sediments to refusal. The methods for the sediment physical analyses were included in the Phase II Pawtuxet River Proposal (CIBA-GEIGY, 1992).

2.5 PHYSICAL CHARACTERIZATION RESULTS

This section combines information collected during the literature review with results of physical characterization conducted during Phases I and II of the RFI to provide an overview of the Pawtuxet River hydrology. Detailed results of the physical characterization are provided in the Phase IA Report (CIBA-GEIGY, 1990) and the Phase I Interim Report (CIBA-GEIGY, 1991).

2.5.1 Flow Characterization

As discussed previously in Section 2.3.4, about 230 square miles of drainage area contribute flow to the Pawtuxet River. The USGS gauge located at Cranston measures flow from about 200 square miles of this drainage area. The Cranston gauge is located about 3 river miles upstream of the

facility (as shown on Figure 2-2).

Based on the USGS data, daily flow in the Pawtuxet River ranged from 22 cubic feet per second (cfs) (in 1944) to 4,190 cfs (in 1983) during the period of record. The average daily flow during the period of record was 347 cfs. The instantaneous discharges measured during the flow characterization study ranged from 138 to 337 cfs at the upstream transect and 130 to 382 cfs at the downstream transect. The low-flow measurements correlated well with instantaneous discharge measurements at the Cranston gauge. As flow increased in the river, the difference between the Cranston gauge measurement and the discharges measured in the Facility Reach increased.

Seasonal flow variations were evaluated by reviewing the USGS data for Cranston, based on the extensive dataset available. Seasonal variations in flow at Cranston should be representative of the variation occurring at the facility. Based on the USGS data, the highest river flows occur in April and the lowest flows occur in August.

River stage height measurements collected for developing the hydrodynamic model of the river showed the river elevation to fluctuate about five feet during the period of record. The greatest short-term fluctuation in river height recorded during this period was a three foot increase in stage over a 48 hour period.

2.5.2 River Bathymetry

A bathymetric map of the Facility Reach was prepared during Phase I and was included in the Phase II Pawtuxet River Proposal (CIBA-GEIGY, 1992). The Facility Reach was re-mapped during the Phase II Hydrological Investigation. This discussion will focus on the Phase II effort, but will incorporate results of the Phase I mapping exercise. Figure 2-4 (sheets 1 through 6) present the bathymetric results for the Pawtuxet River.

A 4.5 mile section of the Pawtuxet River was mapped from the USGS Cranston gauge downstream past the facility to the Pawtuxet Cove Dam. The mapped area extends further upstream and downstream of the area of the river sampled during the Release Characterization (i.e., the Upstream, Upper Facility, Lower Facility and Downstream Reaches). The additional river area was included to provide information required for the hydrodynamic, sediment transport and fate and transport models. For this discussion, the area of the river upstream of the Upstream Reach to the

Cranston gauge will be called the Far Upstream reach. The area downstream of the Downstream Reach to the Pawtuxet Cove Dam will be called the Far Downstream Reach.

The mapping methods were previously discussed in Section 2.4.4. The bathymetric data were collected during February 1992 and reflect water depths in the river at that time. The river water elevation fluctuates seasonally, with higher elevations in the spring and lower elevations in the summer.

The following description of river bathymetry is provided for each of the six reaches. In each section, the river will be described moving from upstream to downstream. Any references to the "left" or "right" bank mean the reader's left or right facing downstream.

Far Upstream Reach: The bathymetry of the Far Upstream Reach is characterized by variable channel shape, from narrow (around 60 feet) with sharply descending banks and a clearly defined center channel about 8 feet deep to relatively wide (100 feet) with gently sloping banks to a water depth of about 5 feet. Through about half of the reach length, the right bank is much steeper than the left bank. In the downstream portion of the reach, both banks are gently sloping to a rounded channel bottom. The maximum water depth within this reach is 8 feet; the minimum water depth within the center channel is 3 feet.

Upstream Reach: The Upstream Reach bathymetry is characterized by fairly consistent river widths of around 100 feet. River depth in this reach is highly variable from around 5 feet to over 14 feet. A deep pool occupies the last meander of this reach, covering about 300 feet.

Upper Facility Reach: The bathymetry of the Upper Facility Reach is characterized by a river width of 120 to 140 feet. The channel depth ranges from 4 to 8 feet, with the shallower depths upstream and the deeper depths downstream. The center channel is fairly wide through this reach (about 70 feet wide). The results of the Phase I and Phase II bathymetry of this reach show similar channel shape, though more detail is shown in the Phase II study due to improved methods of measurement. Water depths are deeper in the Phase II study, reflecting a seasonal variation in river stage.

Lower Facility Reach: The Lower Facility Reach is characterized by a relatively straight channel flowing to the east and slightly north, with a width ranging from 90 to 125 feet. A 12 foot deep

pool is located about 150 feet downstream of the Facility Railroad Bridge. The left bank of the river descends very sharply into this pool. The river becomes shallower, with a depth of 6-7 feet, downstream of this pool for the next 500 feet. At the far downstream end of the Lower Facility Reach, the river is characterized by a steep left bank, descending to a 8 foot deep pool within 20-30 feet of the edge of the river. The right bank in this area of the channel is gently sloping.

Downstream Reach: The Downstream Reach bathymetry is characterized by variable river width, shape and depth. The river width ranges from 75 to 125 feet. Channel shape fluctuates from a wide channel with gently sloping sides to a narrow channel with sharply descending banks. River depth ranges from 6 to 11 feet, with an average channel depth of 7 feet in this reach.

Far Downstream Reach: The Far Downstream Reach bathymetry is characterized by an average river width of about 120 feet, with an average channel depth of 7-8 feet. The river flows due south in the upper portion of this reach for about 1,000 feet. The right bank of the river is gently sloping and the left bank is steep in this section. The river turns due east for the last 1,400 feet before flowing into Pawtuxet Cove. This is the widest section of the river with widths of 200 feet at the furthest downstream section of the reach. As the river widens, it becomes more shallow with maximum channel depths of around 6 feet. Both the left and right banks are gently sloping in this portion of the reach.

Summary of River Bathymetry: Throughout the 4.5 mile section of the Pawtuxet River that was mapped during the RFI, the river ranges from 60 to 200 feet wide, with narrower sections upstream and wider sections downstream, in general. Mid-channel depths range from 3 to 14 feet, with deeper areas occurring upstream of the Facility, in the Upstream Reach, and within the lower end of the Lower Facility Reach. Channel shape is highly variable but tends to be more narrow with steep sides upstream and wider with gently sloping sides downstream.

2.5.3 Sediment Physical Characteristics

This section summarizes the results of the physical characterization of the river sediments outlined in Section 2.4.5. The following characteristics are discussed: sediment thickness, total organic carbon content, grain size, cation exchange capacity, pH, bulk density and porosity. The physical characteristics are summarized in Table 2-2.

Sediment Thickness:

Maps showing sediment thickness based on the probing results are shown in Figure 2-5 (sheets 1 through 6). Forty-nine transects were laid out perpendicular to the river within the 4.5 mile section from the USGS Cranston gauge downstream to the Pawtuxet Cove Dam. The sediment was manually probed to refusal at five points, equally spaced along each of the forty-nine transects. At three narrow sections of the river, only four points were probed along each transect. In total, the sediment was manually probed in 242 locations. Sediment thickness was quantified to the nearest 0.5 foot. Sediment samples were collected at each location where the substrate was not rock, cobbles or gravel, using a grab sampler or hand held corer. A total of 167 grab samples and 26 core samples were collected. Sediment samples were analyzed for total organic carbon content and grain size.

As with the river water depths, the sediment thickness profiles are discussed moving from upstream at the USGS Cranston gauge downstream, past the facility, to the Pawtuxet Cove Dam.

Far Upstream Reach: In the Far Upstream Reach sediment thickness ranged from <0.5 feet to 4.0 feet. Over 90% of the sediments probed are 1.0 foot or less in thickness. About 60% of the sediments are less than or equal to 0.5 feet thick. The few areas where sediments are 3 to 4 feet thick are located close to the bank, within the inside bends of the river, where deposition is likely. In the center channel, the sediment ranges from < 0.5 feet to 1.0 feet thick. The average sediment thickness of the locations probed in the Far Upstream Reach is 0.6 feet.

Upstream Reach: Sediment depths in the Upstream Reach range from <0.5 feet to 3.5 feet thick. About 75% of the sediments probed are less than or equal to 0.5 feet thick. As with the Far Upstream Reach, the three areas where sediments are over one foot thick are located within the inside bends of the river, nearest the bank. The sediment in the center channel of the Upstream Reach is 0.5 feet thick or less. The average sediment thickness of the locations probed in the Upstream Reach is 0.5 feet.

Upper Facility Reach: The sediments become thicker in the Upper Facility Reach, where more than 75% of the sediments probed are 0.5 feet thick or greater. Sediment thickness within this reach ranges from <0.5 feet to 4.0 feet. The deepest sediment is located on the north bank of the river, upstream of the railroad bridge. The sediment thickness in the center channel ranges from

0.5 to 1.5 feet. The average sediment thickness of the locations probed in the Upper Facility Reach is 1.2 feet.

A separate probing study was performed in the Upper Facility Reach to delineate the vertical and horizontal extent of stained material in the sediment adjacent to the former cofferdam area, located on the north side of the river between the railroad bridge and pedestrian walkway. Sediments were probed on a five-foot grid, over an area approximately 150 feet long and 50 feet wide. A different technique was used to measure sediment thickness during this study. The sediment probe was forced into the sediment using a weighted driver so that deeper penetration was possible. Using this method, sediment thickness ranged from 0 to 7.5 feet. The results of this study are included in Appendix A.

Lower Facility Reach: Sediment thickness in the Lower Facility Reach ranges from <0.5 feet to 4.0 feet. The center channel sediment ranges from <0.5 feet to 2.5 feet thick. The thickest sediments are located immediately downstream of the deep pool that lies about 150 feet downstream of the railroad bridge. The average sediment thickness of the locations probed in the Lower Facility Reach is 0.9 feet.

Downstream Reach: In the Downstream Reach sediments range from <0.5 to 2.5 feet thick. The thickest sediment is found just downstream of the Lower Facility Reach, on the north side of the river and further downstream, along the inside bends of the river. Sediment in the center channel ranges from <0.5 to 1.5 feet thick. The average sediment thickness of the locations probed in the Downstream Reach is 0.7 feet.

Far Downstream Reach: Sediment thickness in the Far Downstream Reach ranges from <0.5 to 4.0 feet thick. The center channel sediment thickness ranges from 1.0 to 2.0 feet. The average sediment thickness in this reach is 1.8 feet.

In summary, sediment thickness throughout the 4.5 mile stretch of the Pawtuxet River that runs from the USGS gauge at Cranston to the Pawtuxet Cove Dam varies from 0 to 4 feet thick, using manual probing techniques. Deeper sediments occur in the inside bends of the river and downstream of deep pools.

Sediment TOC Content:

TOC content was measured on sediment sampled during the Physical and Release Characterization. These samples were collected from the top 0-6 inches of the sediment. The TOC results were combined resulting in a database of 241 surface sediment samples. One sample collected from the former Cofferdam Area was not included in this dataset. The TOC value (92.3%) measured for this sample was considered an outlier. Deep sediment cores collected from the Upper Facility Reach during Phase II of the Release Characterization were also analyzed for TOC; these samples provided information on TOC concentration.

Table 2-2 summarizes TOC results by reach for surface sediments (0-6 inches). Excluding TOC results from the stained material, the sediment TOC content ranged from 220 to 134,000 ppm. The highest average and median TOC values were observed within the Upstream Reach and the Upper Facility Reach. Average and median TOC concentrations in the Far Upstream, Lower Facility, Downstream and Far Downstream Reaches are similar. When data from all reaches are combined, the average TOC concentration in the surface sediment is 17,983 ppm (or 1.8%).

Table 2-2 summarizes sediment TOC results by depth for the Upper Facility Reach. The highest TOC concentrations were measured in the surface sediment (0-6 inches). The average TOC concentration measured in the surface sediment of 30,955 ppm was over three times greater than the average TOC concentration measured in the shallow sediments (1-2 feet) and deep sediments (below 2 feet). Median and average TOC concentrations in the 1-2 foot and over 2 foot depths were similar.

Sediment Grain Size:

Sediments are composed of particles varying in size and shape. The proportion of particles of a given size that compose a sediment define the sediment texture. Sediment texture is determined by mechanical separation of the particles into different size groups. There are different classification systems in use for defining textural class and each system varies slightly in particle size limits. For this study, the American Society for Testing & Materials (ASTM) Unified Particle Size Limit Classification was used (ASTM, 1990). Using this classification system, the clay and silt particles, or fines, are those particles less than 0.075 mm in diameter, the sand particles range from 0.075 to 5 mm in diameter and the gravel ranges from 5.0 mm to 3 inches in diameter. In general, the larger

the proportion of small diameter particles, or fines, in a sediment, the higher the capacity to adsorb metallic cations and organic compounds from the river water due to the higher cation exchange capacity of the smaller particles.

During the physical characterization of the river, 172 samples were collected for particle size analysis. The results of this analysis are summarized in Table 2-2. The percent fines in these samples ranged from 0.1% to 79.9%, with an overall average for all samples collected of 11.5% fines. The average and median percent fines in the Far Upstream and Upstream Reaches are slightly lower than that of the remaining reaches. In general, the finer texture sediments also had higher TOC content and were located in areas where sediments were deeper (depositional zones).

Sediment Cation Exchange Capacity:

Cation Exchange Capacity (CEC) is a measurement of the ability of a soil or sediment to adsorb positively charged ions or cations. CEC is expressed in terms of milliequivalents per 100 grams of soil or sediment (meq/100 gm). CEC is affected by particle size, organic matter content, type of clay present and pH. Higher CEC values are found in soils or sediments with smaller particle sizes (i.e., clays), higher organic matter content, expanding clays and/or higher pH values. Soil CEC can vary between not detected and 60 meq/100 gm. The higher the CEC, the greater the ability of the soil or sediment to retain cations (Brady, 1974).

Twenty-seven sediment samples were collected during the Phase I physical characterization for CEC analysis. The results are presented in Table 2-2. The CEC of these sediments ranges from not detected to 28 meq/100 gms. The highest average CEC was 7.8 meq/100 gms in the Facility Reach. The higher CEC values in the Facility Reach are probably attributable to the higher TOC content of these sediments. The average CEC in sediments from the Upstream and Downstream Reaches are similar at 4.9 and 4.3 meq/100 gm, respectively. The average CEC for all reaches combined is 6.5 meq/100 gm.

Sediment pH:

The pH of the 25 sediment samples collected during the Phase I Hydrological Investigation, as shown in Table 2-2, range from 4.7 to 7.8 S.U. The average pH for the Upstream, Facility and

Downstream Reaches is 6.4, 6.8 and 6.1 S.U., respectively. No significant variation in pH was observed between reaches. The average pH of all sediments collected was 6.4 S.U.

Sediment Bulk Density:

The bulk density of a sediment is the dry mass or weight of a unit volume of sediment. Bulk density is measured on "undisturbed" cores collected from the sediment. Thirty-six sediment cores were collected for bulk density analysis during the Physical Characterization of the river.

The results of the bulk density analysis are shown in Table 2-2. The bulk density of the sediment ranged from 27.4 to 85.9 lbs/cubic foot, with an average of 58.6 lbs/cubic foot for all cores. The average bulk density for sediment in the Upstream, Facility and Downstream Reaches was 53.8, 59.1 and 61.2 lbs/cubic foot, respectively (samples from the Far Upstream Reach were combined with the Upstream Reach and samples from the Far Downstream Reach were combined with the Downstream Reach for this calculation due to the limited number of samples from the extreme reaches). In comparison, the bulk density of clayey or silty surface soil ranges from 65 to 100 lbs/cubic foot; sands and sandy loams range from 75 to 110 lbs/cubic foot; and very compact subsoils weigh as much as 125 lbs/cubic foot (Brady, 1974).

Sediment Porosity:

The pore space of a sediment is that portion occupied by water or gases. The amount of pore space is determined by the arrangement of the solid particles in the sediment. In sands or compact sediments, the particles lie close together and the porosity is low. In finer textured soils with aggregates of material, the pore space per unit volume is high. Porosity is calculated by dividing the bulk density by the particle density or specific gravity of a sediment (Brady, 1974). In the ten samples analyzed for bulk density and specific gravity during the Phase I physical characterization, the porosity ranges from 51.5 to 83.7 %.

2.5.4 Summary of Pawtuxet River Physical Characterization

The Pawtuxet River in the study area is a fourth order stream that drains about 230 square miles of mixed industrial and urban land. Flow in the river is regulated by reservoirs upstream. The river is classified as "Class D" by RIDEM below the Cranston Sewage Treatment Plant, upstream of the

facility. Class D waters are suitable for migration of fish and have good aesthetic value, but should not be used for drinking or contact recreation.

The average daily flow in the river is about 350 cfs. Highest flows occur in April; lowest flows occur in August. The river fluctuated five feet in stage height during our investigation.

In the 4.5 mile section of river from the Cranston gauge to Pawtuxet Cove Dam, the river varies from about 60 to 200 feet wide, with mid-channel depths of 3 to 14 feet. Sediment thickness ranges from <0.5 to 4 feet thick, based on manual probing of the sediments. Depositional zones, or areas where sediments are thicker, tend to occur on the inside bends of the river and just downstream of large pools. Sediment within these depositional zones is typically characterized by high TOC content, higher percent fines and higher CEC values.

Tables

TABLE 2-1
PAWTUXET RIVER
GENERAL WATER QUALITY
UPSTREAM AND DOWNSTREAM

| Water Quality Parameter | Upstream Result | Sample Size | Downstream Result | Sample Size |
|---|-----------------|-------------|-------------------|-------------|
| Specific Conductance (uS/cm) | 227.7 | 114 | 262.3 | 102 |
| Total Dissolved Solids (residue @ 180C) | 58 | 4 | nm | 0 |
| Total Suspended Solids (residue @ 105C) | 10.6 | 33 | 11.2 | 33 |
| pH (S.U.) | 6.44 | 115 | 6.48 | 102 |
| Turbidity (NTU) | 2.37 | 53 | 2.60 | 53 |
| Temperature (C) | 12.4 | 191 | 12.6 | 104 |
| Biological Oxygen Demand (mg/l) | 2.55 | 31 | 5.62 | 32 |
| Chemical Oxygen Demand (mg/l) | 29.8 | 32 | 33.9 | 31 |
| Dissolved Oxygen (mg/l) | 9.08 | 111 | 8.01 | 103 |
| Hardness (mg/l CaCO ₃) | 37.8 | 21 | 44.8 | 16 |
| Alkalinity (as CaCO ₃) | 17.1 | 27 | 22.9 | 15 |
| Total Ammonia as N (mg/l) | 0.826 | 109 | 1.37 | 103 |
| Nitrate/Nitrite as N (mg/l) | 0.622 | 109 | 0.780 | 103 |
| Total Phosphorus as P (mg/l) | 0.358 | 111 | 0.507 | 103 |
| Total Ortho-Phosphorus as P (mg/l) | 0.265 | 103 | 0.410 | 103 |
| Total Organic Carbon as C (mg/l) | 7.13 | 12 | 10.96 | 12 |

U.S.G.S. 1990. Water Resources Investigation Report 90-4082.

nm = no measurement

TABLE 2-2
SUMMARY OF PHYSICAL CHARACTERIZATION
PAWTUXET RIVER SEDIMENT

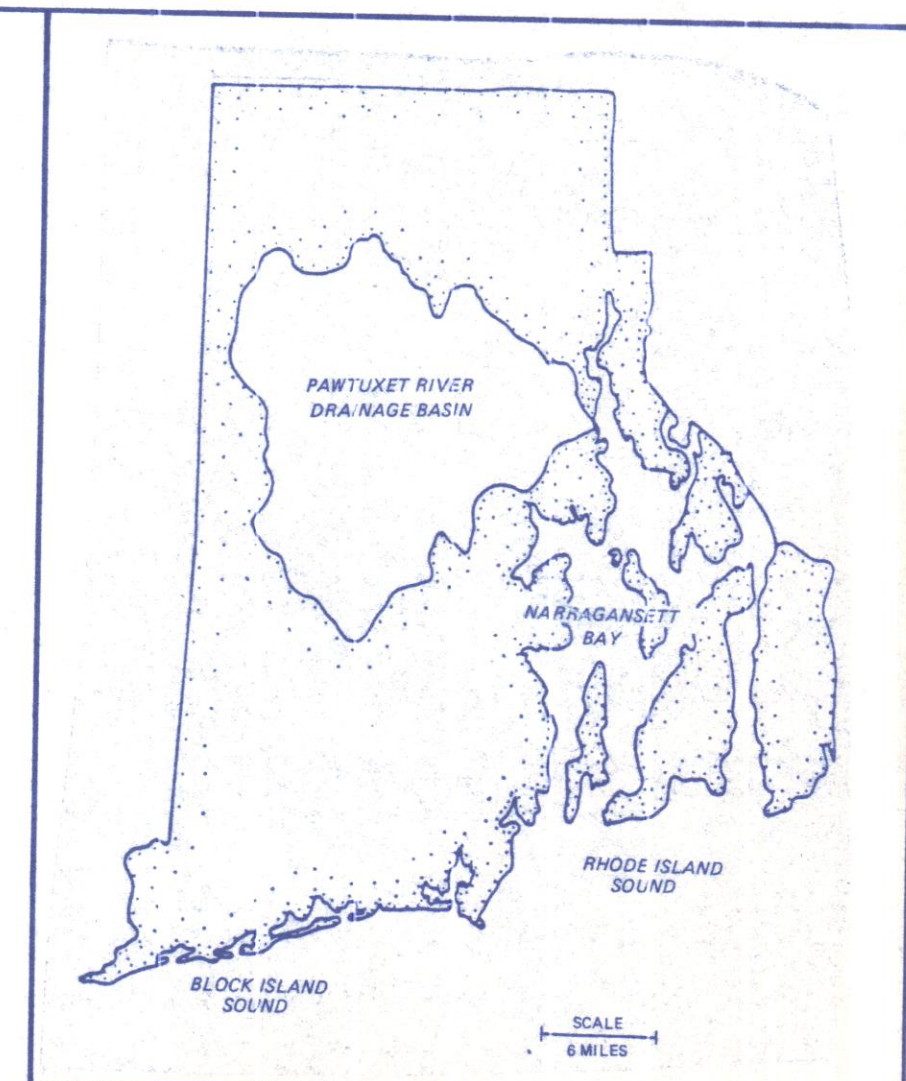
| PHYSICAL CHARACTERISTIC | Reach (units) | Far Upstream | Upstream | Upper Facility | Lower Facility | Downstream | Far Downstream | All Reaches |
|---------------------------------|-----------------------------|--------------|----------|----------------|----------------|------------|----------------|-------------|
| Total Organic Carbon | (ppm) | | | | | | | |
| Number of Samples | | 31 | 39 | 40 | 74 | 46 | 11 | 241 |
| Minimum | | 1,320 | 220 | 1,600 | 370 | 310 | 2,420 | 220 |
| Median | | 5,700 | 9,300 | 18,600 | 4,565 | 6,960 | 4,680 | 6,330 |
| Average | | 11,742 | 20,488 | 30,955 | 14,797 | 15,012 | 13,377 | 17,983 |
| Maximum | | 62,600 | 120,000 | 111,000 | 134,000 | 82,600 | 51,900 | 134,000 |
| Percent Fines | (%) | | | | | | | |
| Number of Samples | | 31 | 26 | 30 | 41 | 32 | 12 | 172 |
| Minimum | | 0.1% | 0.1% | 0.2% | 0.2% | 0.1% | 0.7% | 0.1% |
| Median | | 2.1% | 2.9% | 5.0% | 5.9% | 4.9% | 4.5% | 4.7% |
| Average | | 8.9% | 7.2% | 13.4% | 13.2% | 13.3% | 11.8% | 11.5% |
| Maximum | | 55.0% | 36.4% | 64.1% | 51.3% | 79.9% | 47.3% | 79.9% |
| Cation Exchange Capacity | (meq/100 g) | | | | | | | |
| Number of Samples | | NC | 5 | NC | 16 | 6 | NC | 27 |
| Minimum | | NC | 1.8 | NC | ND | 2.0 | NC | ND |
| Median | | NC | 5.0 | NC | 4.8 | 2.0 | NC | 4.6 |
| Average | | NC | 4.9 | NC | 7.8 | 4.3 | NC | 6.5 |
| Maximum | | NC | 8.5 | NC | 28.0 | 12.0 | NC | 28.0 |
| pH | (SU) | | | | | | | |
| Number of Samples | | NC | 5.0 | NC | 14.0 | 6.0 | NC | 25.0 |
| Minimum | | NC | 5.4 | NC | 4.7 | 5.3 | NC | 4.7 |
| Median | | NC | 6.1 | NC | 6.8 | 6.0 | NC | 6.5 |
| Average | | NC | 6.4 | NC | 6.8 | 6.1 | NC | 6.4 |
| Maximum | | NC | 7.8 | NC | 7.8 | 6.9 | NC | 7.8 |
| Bulk Density | (lbs/ft³) | | | | | | | |
| Number of Samples | | NC | 7 | NC | 20 | 9 | NC | 36 |
| Minimum | | NC | 37.6 | NC | 27.4 | 47.3 | NC | 27.4 |
| Median | | NC | 54.3 | NC | 63.1 | 56.9 | NC | 57.8 |
| Average | | NC | 53.8 | NC | 59.1 | 61.2 | NC | 58.6 |
| Maximum | | NC | 64.2 | NC | 83.8 | 85.9 | NC | 85.9 |

NC - sample not collected at this location.

ND - Not Detected

• Note: Outlier associated with stained material (TOC = 923,000 ppm) has been excluded.

Figures

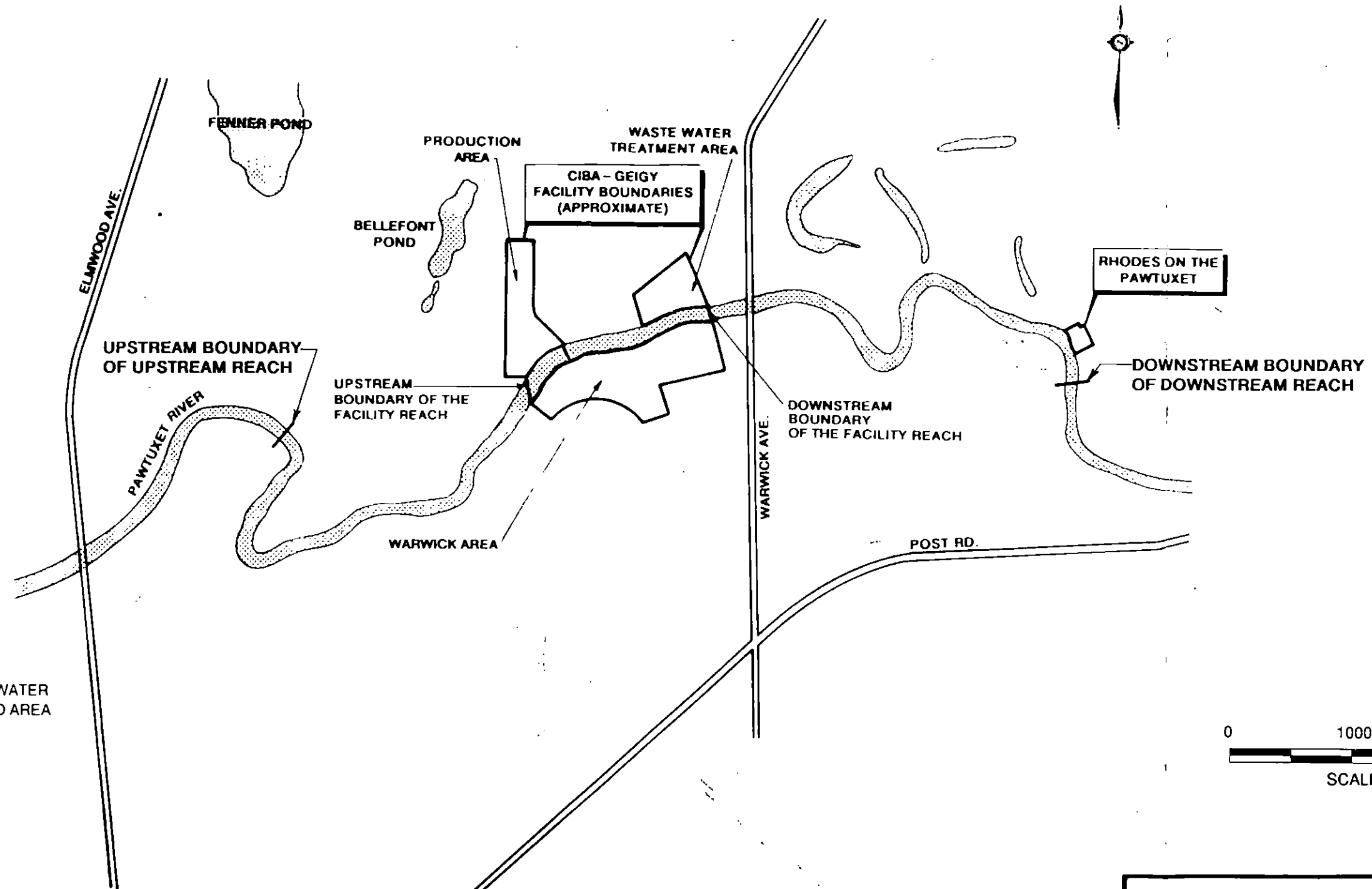


- LEGEND**
- (A) WATER QUALITY CLASS
 - (B) LOCATION OF USGS GAUGING STATION

NOTE: THE MAIN STEM OF THE PAWTUXET RIVER HAS A CLASS C STANDARD BUT IS CONSIDERED CLASS D DOWNSTREAM OF RIVER MILE 6.5.

| PAWTUXET RIVER DRAINAGE BASIN, WATER CLASSIFICATION, AND LOCATION OF USGS GAUGING STATIONS | | |
|--|--------------------|--------------------|
| WOODWARD - CLYDE CONSULTANTS | | |
| ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT WAYNE, NEW JERSEY | | |
| DR. BY: KF | SCALE: AS SHOWN | PROJ. NO.: 87X4660 |
| CK'D. BY: KAK | DATE: MAR 28, 1995 | FIG. NO.: 2-2 |

BASE MAP SOURCE: PLAN ENTITLED "PRESENT CLASSIFICATION OF WATER QUALITY" (1967), STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS, DEPARTMENT OF HEALTH, DIVISION OF WATER POLLUTION CONTROL. MODIFIED BASED ON "WATER QUALITY REGULATIONS FOR WATER POLLUTION CONTROL" (RIDEM, 1983).



LEGEND

MAJOR SURFACE WATER BODIES IN MAPPED AREA

NOTE:

SEDIMENT SAMPLES WERE ANALYZED FOR APPENDIX IX COMPOUNDS AND BIOASSAY.

BASE MAP SOURCE:

AERIAL PHOTOGRAPHS BY GEOD CORPORATION OF NEWFOUNDLAND, NEW JERSEY.
DATE FLOWN: 2 APRIL 1989.

0 1000 2000 FT
SCALE

THE PAWTUXET RIVER REACHES: UPSTREAM, FACILITY, AND DOWNSTREAM

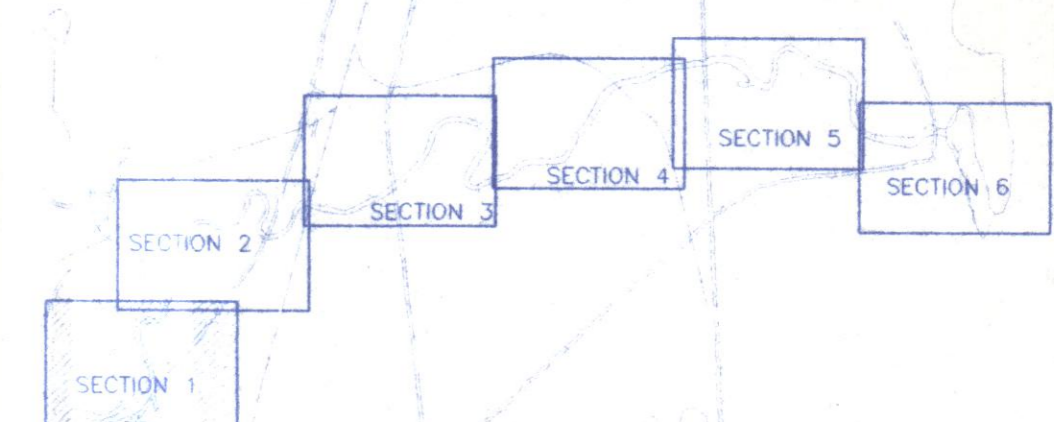
WOODWARD - CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
WAYNE, NEW JERSEY

| | | |
|--------------|--------------------|--------------------|
| DR. BY: BAS | SCALE: 1:12000 | PROJ. NO.: 87X4660 |
| CK'D BY: EMH | DATE: JAN 12, 1996 | FIG. NO.: 2-3 |



⊕ - SURVEY CONTROL POINTS. (WATER DEPTH CONTOURS ARE IN 1.0 FOOT INTERVALS).



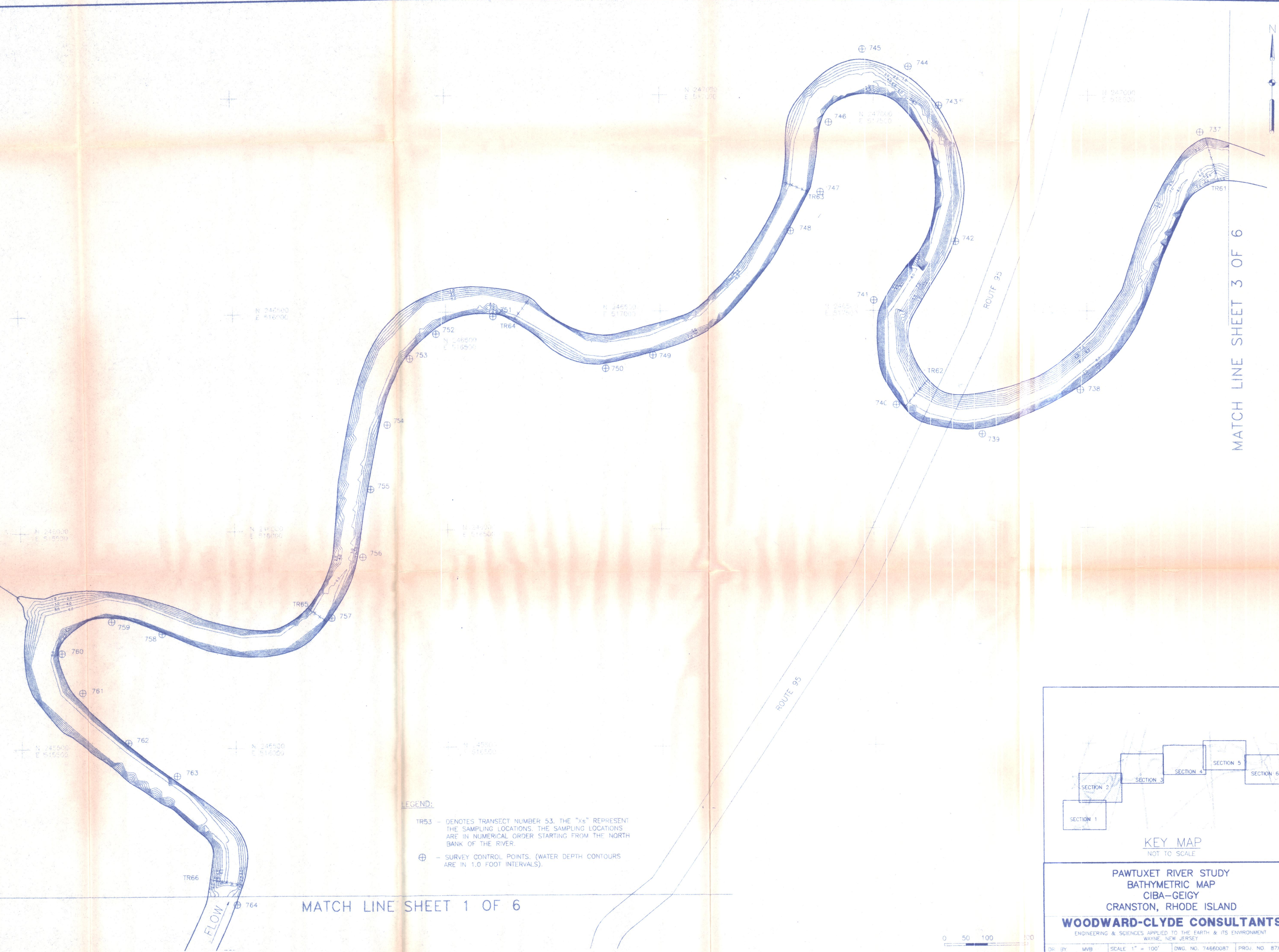
KEY MAP
NOT TO SCALE

PAWTUXET RIVER STUDY
BATHYMETRIC MAP
CIBA-GEIGY
CRANSTON, RHODE ISLAND

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | | | | | |
|---------|-----|-------|--------------|----------|--------------|-----------|---------|
| DR. BY | MVB | SCALE | 1" = 100' | DWG. NO. | 74660092 | PROJ. NO. | 87X4660 |
| CK'D BY | KAK | DATE | FEB 20, 1996 | FIG. NO. | 2-4 (1 OF 6) | | |

The name: K:\AD\03\87\4660\74660093.DWG, Last edited: 96/02/20 @ 14:11



LEGEND:

TR53 - DENOTES TRANSECT NUMBER 53. THE "xs" REPRESENT THE SAMPLING LOCATIONS. THE SAMPLING LOCATIONS ARE IN NUMERICAL ORDER STARTING FROM THE NORTH BANK OF THE RIVER.

⊕ - SURVEY CONTROL POINTS. (WATER DEPTH CONTOURS ARE IN 1.0 FOOT INTERVALS).

KEY MAP
NOT TO SCALE

SECTION 1 SECTION 2 SECTION 3 SECTION 4 SECTION 5 SECTION 6

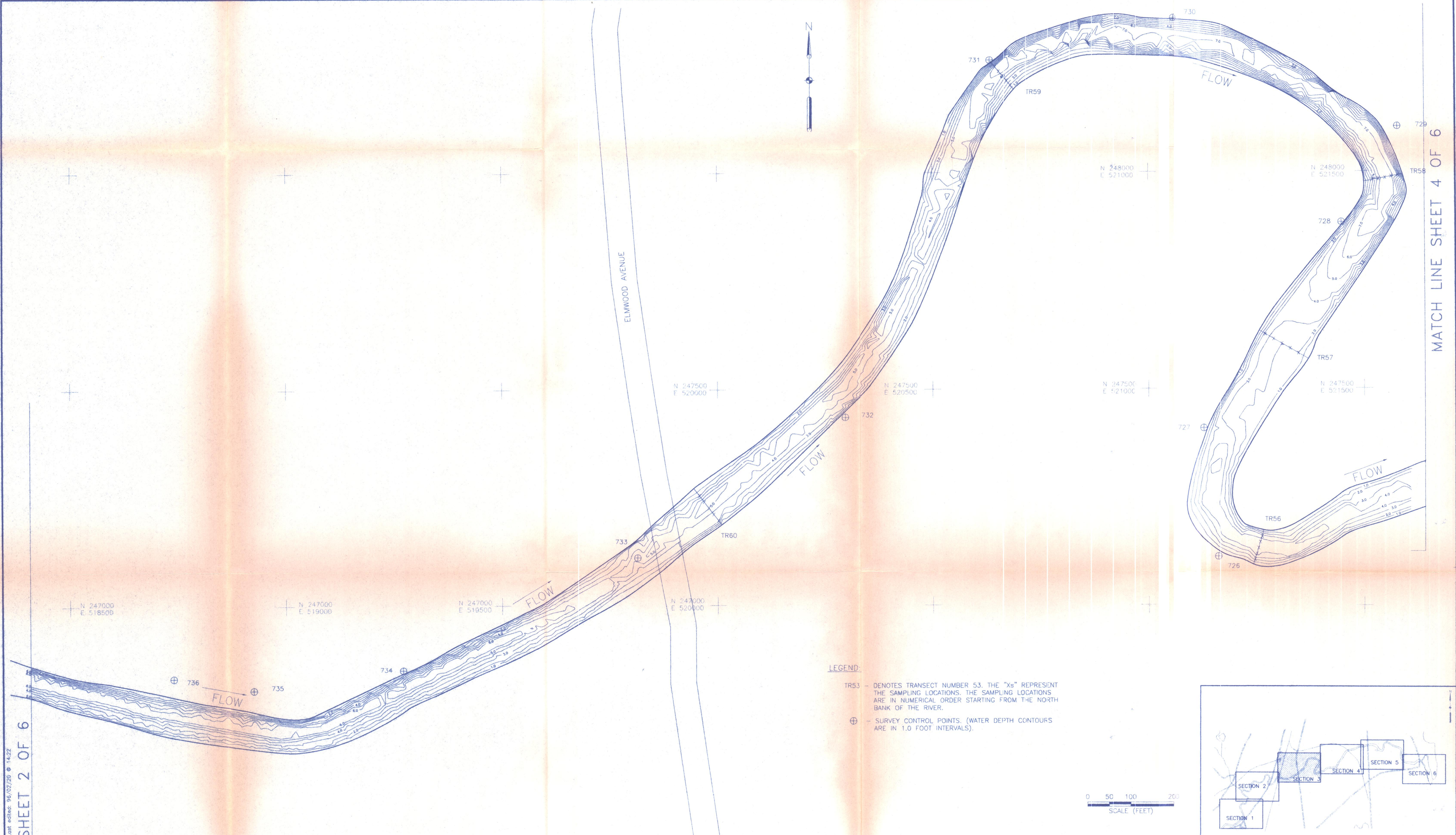
**PAWTUXET RIVER STUDY
BATHYMETRIC MAP
CIBA-GEIGY
CRANSTON, RHODE ISLAND**

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | |
|--------------|--------------------|-----------------------|-------------------|
| DR. BY: MVB | SCALE: 1" = 100' | DWG. NO. 74660087 | PROJ. NO. 87X4660 |
| CHK. BY: KAK | DATE: FEB 20, 1996 | FIG. NO. 2-4 (2 OF 6) | |

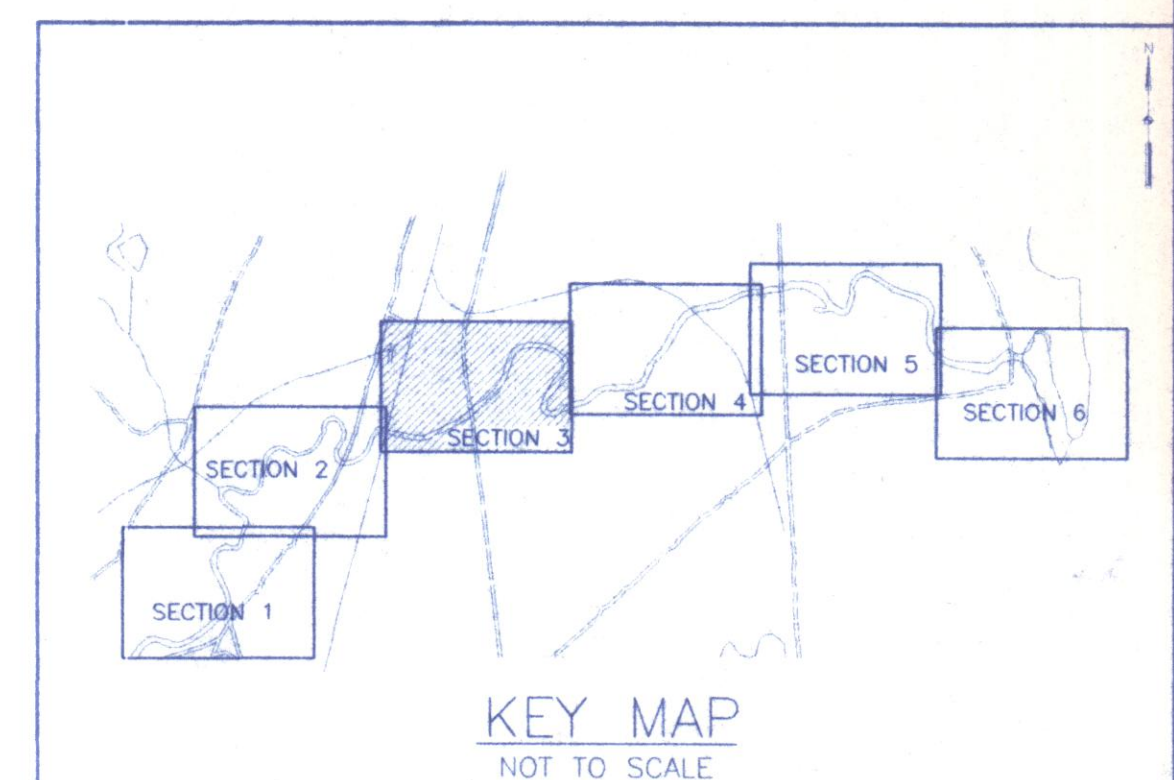
File Name: K:\CADD\87X4660\74660094.DWG Plot Date: 9/1/2000 14:22

MATCH LINE SHEET 2 OF 6



LEGEND:

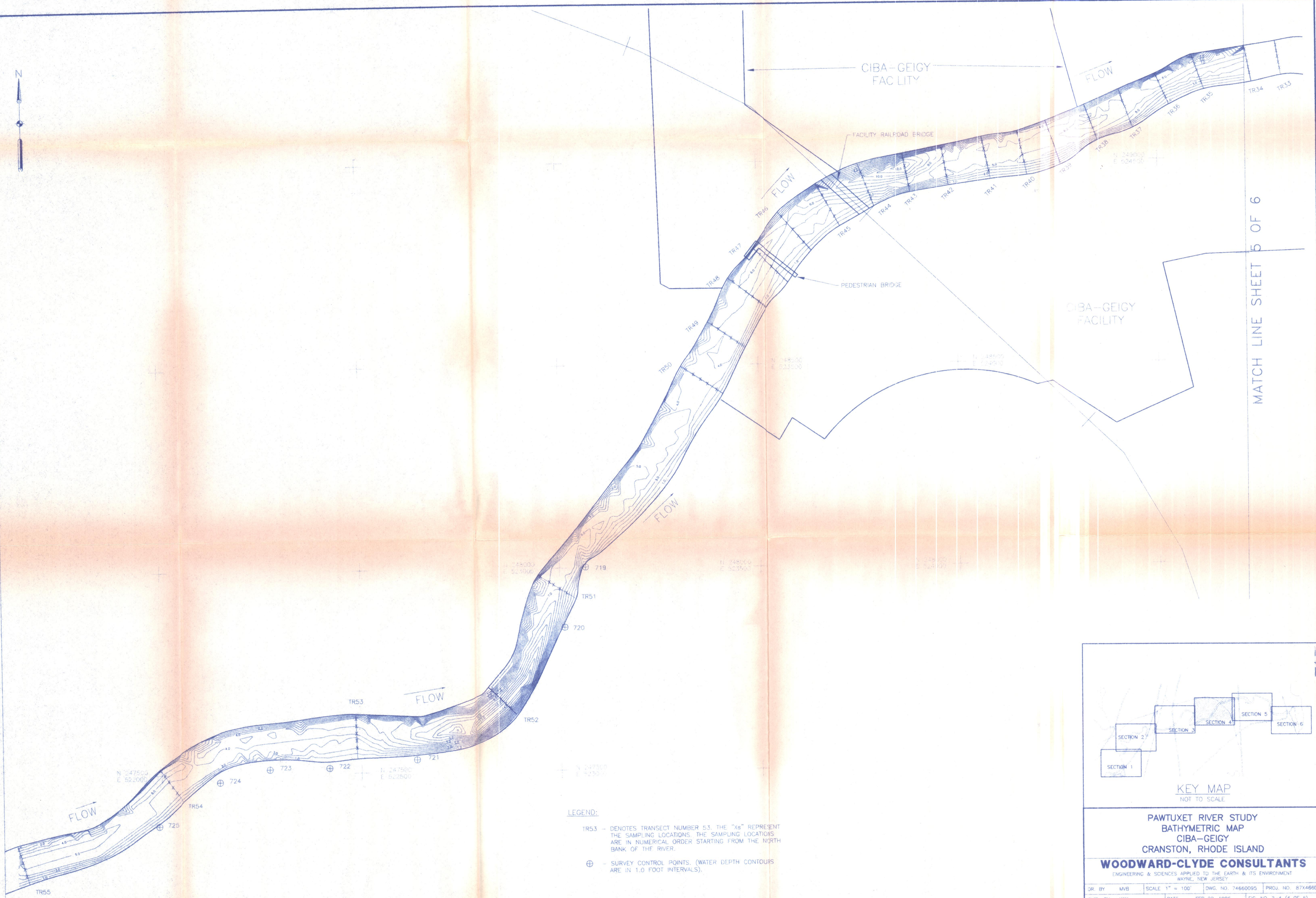
- TR53 - DENOTES TRANSECT NUMBER 53. THE "Xs" REPRESENT THE SAMPLING LOCATIONS. THE SAMPLING LOCATIONS ARE IN NUMERICAL ORDER STARTING FROM THE NORTH BANK OF THE RIVER.
- ⊕ - SURVEY CONTROL POINTS. (WATER DEPTH CONTOURS ARE IN 1.0 FOOT INTERVALS).



| | | | | | |
|--|-----|-------|--------------|-----------|--------------|
| PAWTUXET RIVER STUDY BATHYMETRIC MAP CIBA-GEIGY CRANSTON, RHODE ISLAND | | | | | |
| WOODWARD-CLYDE CONSULTANTS | | | | | |
| ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT WAYNE, NEW JERSEY | | | | | |
| DR. BY | MVB | SCALE | 1" = 100' | DWG. NO. | 74660094 |
| CK'D. BY | KAK | DATE | FEB 20, 1996 | PROJ. NO. | 87X4660 |
| | | | | FIG. NO. | 2-4 (3 OF 6) |

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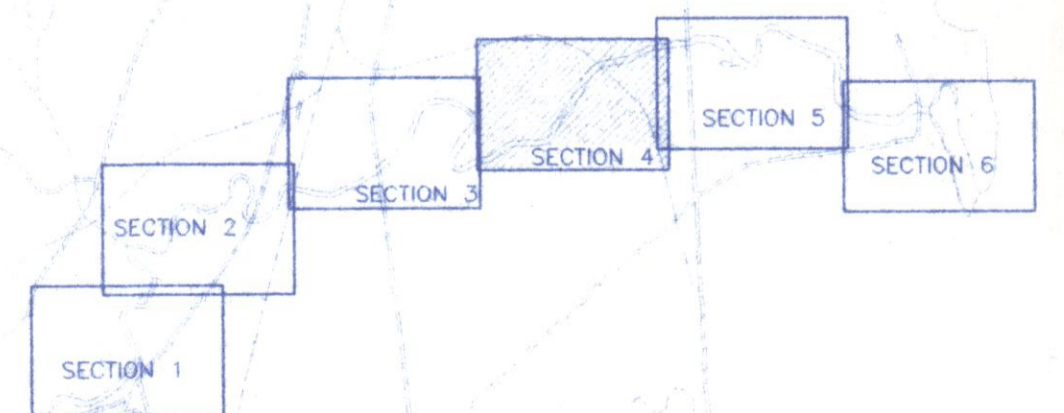
MATCH LINE SHEET 3 OF 6



MATCH LINE SHEET 5 OF 6

LEGEND:

- TR53 - DENOTES TRANSECT NUMBER 53. THE "xs" REPRESENT THE SAMPLING LOCATIONS. THE SAMPLING LOCATIONS ARE IN NUMERICAL ORDER STARTING FROM THE NORTH BANK OF THE RIVER.
- ⊕ - SURVEY CONTROL POINTS. (WATER DEPTH CONTOURS ARE IN 1.0 FOOT INTERVALS).



KEY MAP
NOT TO SCALE

**PAWTUXET RIVER STUDY
BATHYMETRIC MAP
CIBA-GEIGY
CRANSTON, RHODE ISLAND**

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

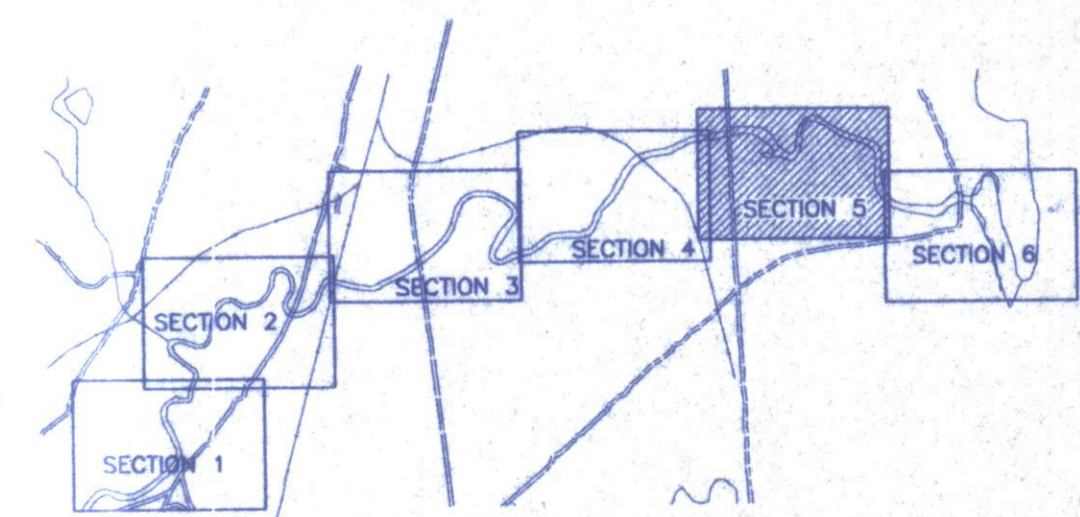
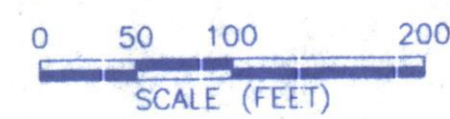
| | | | | | | | |
|-----------|-----|-------|--------------|----------|--------------|-----------|---------|
| DR. BY | MVB | SCALE | 1" = 100' | DWG. NO. | 74660095 | PROJ. NO. | 87X4660 |
| CHK'D. BY | KAK | DATE | FEB 20, 1996 | FIG. NO. | 2-4 (4 OF 6) | | |

WARWICK AVENUE



LEGEND:

- TR53 - DENOTES TRANSECT NUMBER 53. THE "Xs" REPRESENT THE SAMPLING LOCATIONS. THE SAMPLING LOCATIONS ARE IN NUMERICAL ORDER STARTING FROM THE NORTH BANK OF THE RIVER.
- ⊕ - SURVEY CONTROL POINTS. (WATER DEPTH CONTOURS ARE IN 1.0 FOOT INTERVALS).



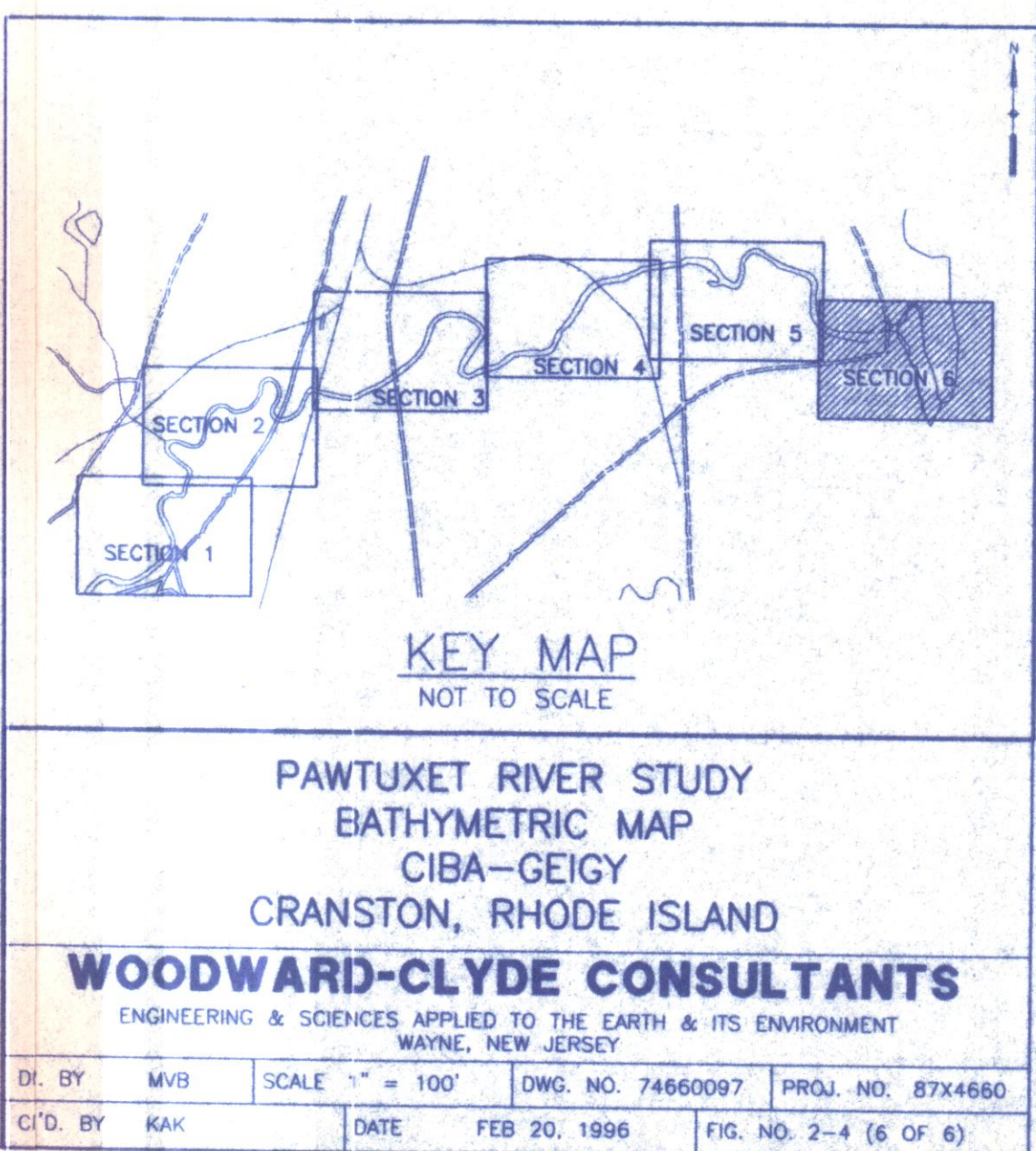
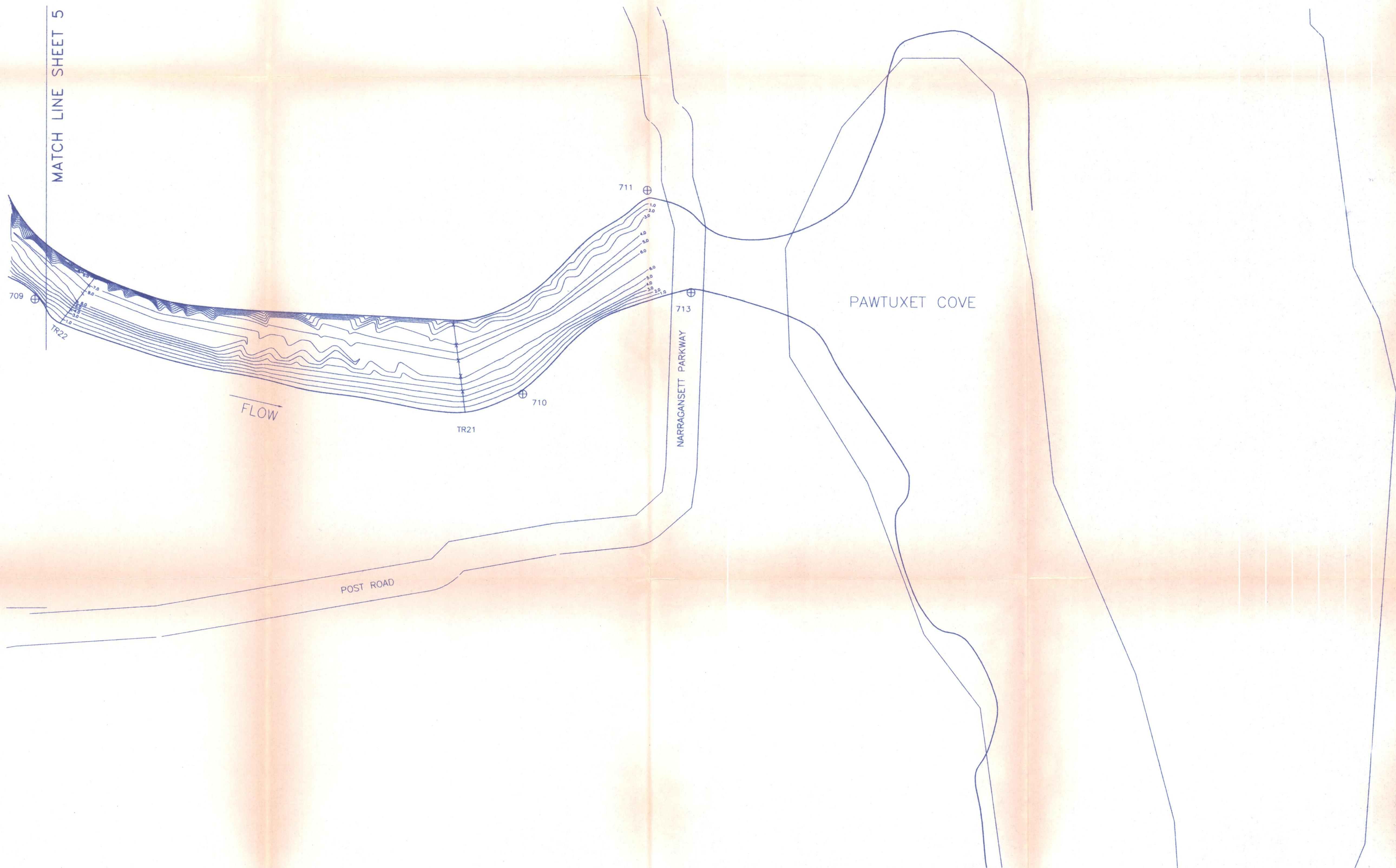
PAWTUXET RIVER STUDY
BATHYMETRIC MAP
CIBA-GEIGY
CRANSTON, RHODE ISLAND

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | | | | | |
|----------|-----|-------|--------------|----------|--------------|-----------|---------|
| DR. BY | MVB | SCALE | 1" = 100' | DWG. NO. | 74660096 | PROJ. NO. | 87X4660 |
| CK'D. BY | KAK | DATE | FEB 20, 1996 | FIG. NO. | 2-4 (5 OF 6) | | |

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MATCH LINE SHEET 5 OF 6





⊕ - SURVEY CONTROL POINTS. (SEDIMENT DEPTH-1 CONTOURS ARE IN 0.5 FOOT INTERVALS).



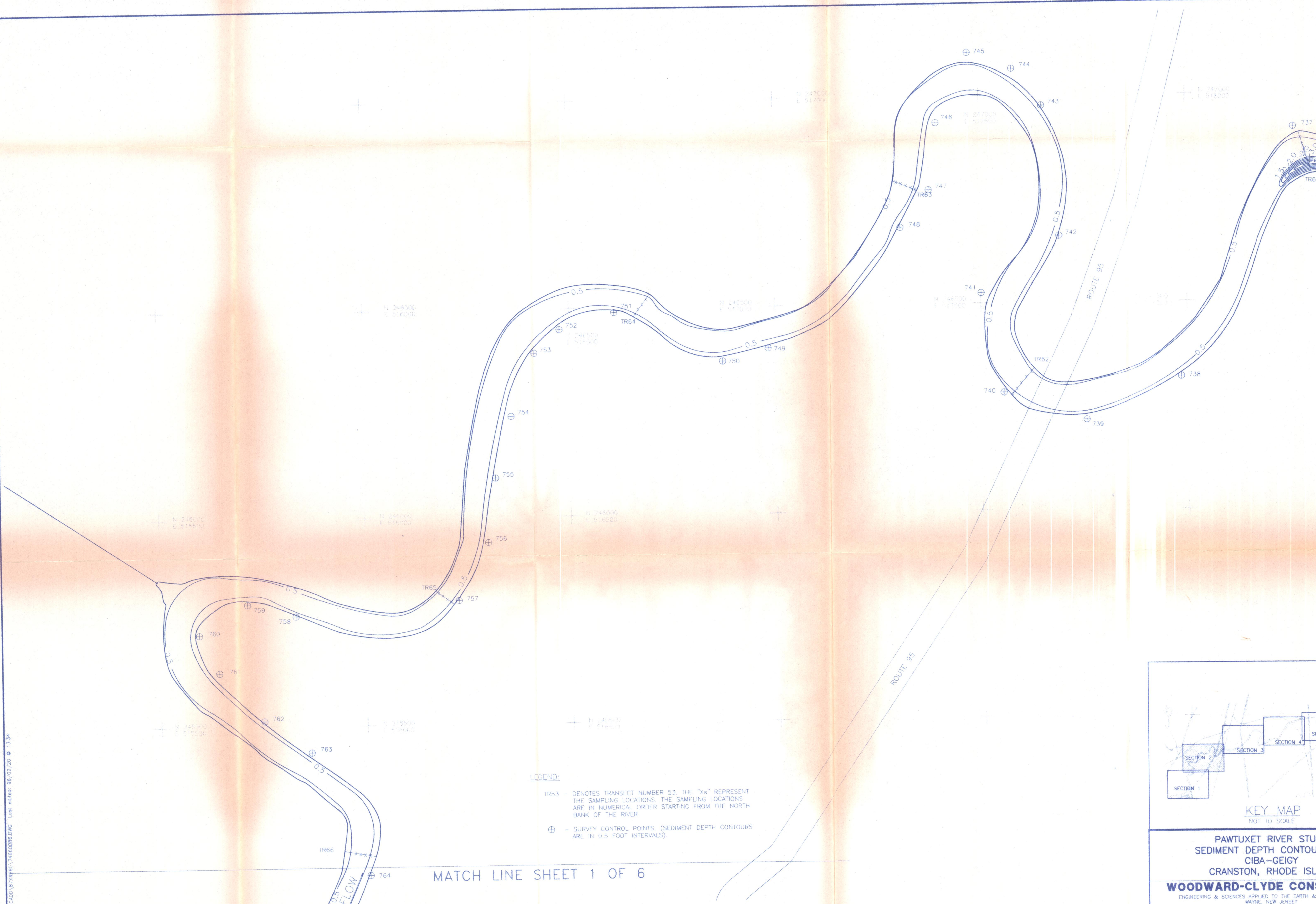
WOODWARD-CLYDE CONSULTANTS

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WAYNE, NEW JERSEY

| | | | | | | | |
|-----------|-----|-------|--------------|----------|--------------|-----------|---------|
| DR. BY | MVB | SCALE | 1" = 100' | DWG. NO. | 74660086 | PROJ. NO. | 87X4660 |
| CHK'D. BY | KAK | DATE | FEB 20, 1996 | FIG. NO. | 2-5 (1 OF 6) | | |



MATCH LINE SHEET 3 OF 6



LEGEND:

TR53 - DENOTES TRANSECT NUMBER 53. THE "xs" REPRESENT THE SAMPLING LOCATIONS. THE SAMPLING LOCATIONS ARE IN NUMERICAL ORDER STARTING FROM THE NORTH BANK OF THE RIVER.

⊕ - SURVEY CONTROL POINTS. (SEDIMENT DEPTH CONTOURS ARE IN 0.5 FOOT INTERVALS).

MATCH LINE SHEET 1 OF 6

KEY MAP
NOT TO SCALE

PAWTUXET RIVER STUDY
SEDIMENT DEPTH CONTOUR MAP
CIBA-GEIGY
CRANSTON, RHODE ISLAND

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | | | | | |
|-----------|-----|-------|--------------|----------|--------------|-----------|---------|
| DR. BY | MYB | SCALE | 1" = 100' | DWG. NO. | 74660087 | PROJ. NO. | 87X4660 |
| CHK'D. BY | KAK | DATE | FEB 20, 1996 | FIG. NO. | 2-5 (2 OF 6) | | |

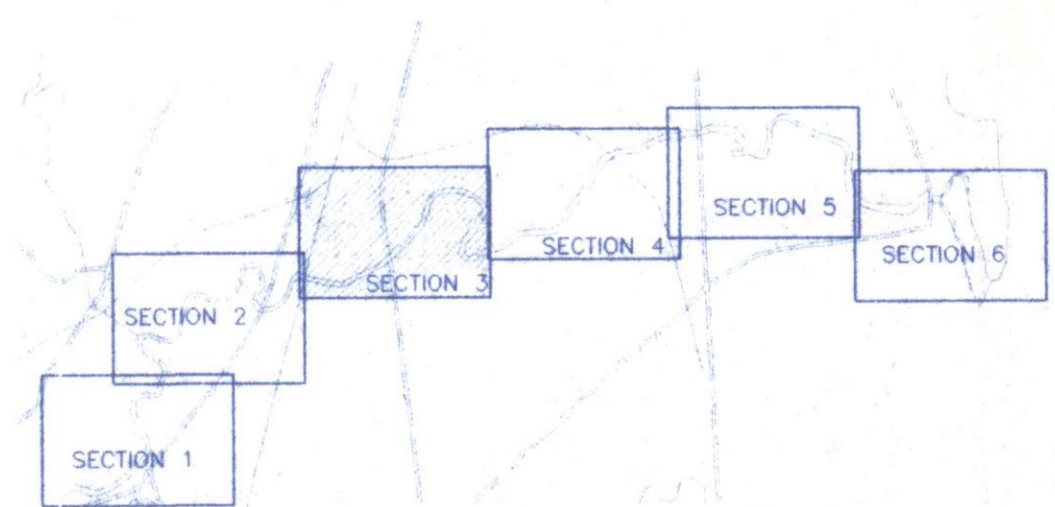
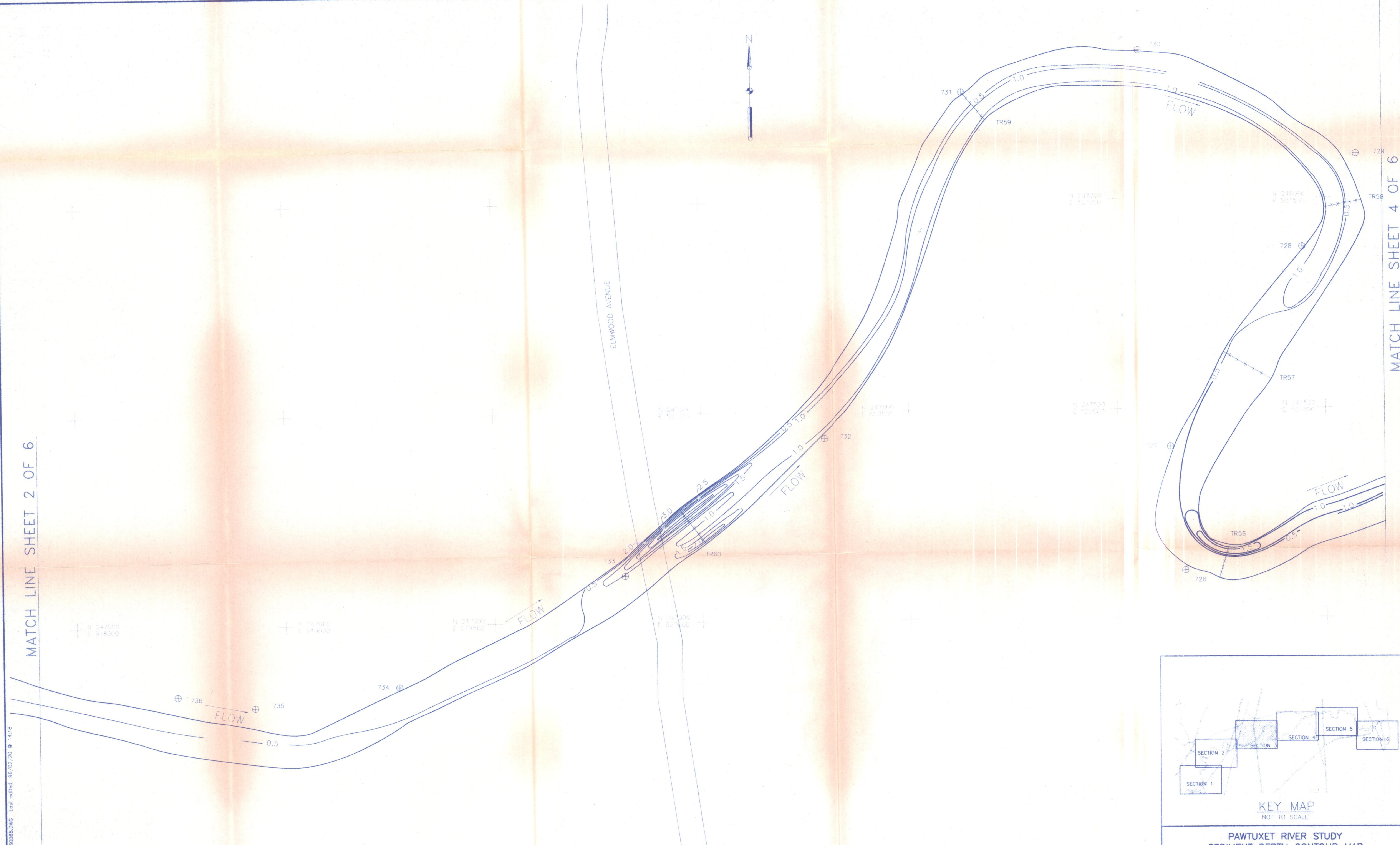
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MATCH LINE SHEET 2 OF 6

File name: K:\GDD\37X4660\74660088.DWG Last edited: 95/02/20 @ 14:18



ELMWOOD AVENUE



KEY MAP
NOT TO SCALE

PAWTUXET RIVER STUDY
SEDIMENT DEPTH CONTOUR MAP
CIBA-GEIGY
CRANSTON, RHODE ISLAND

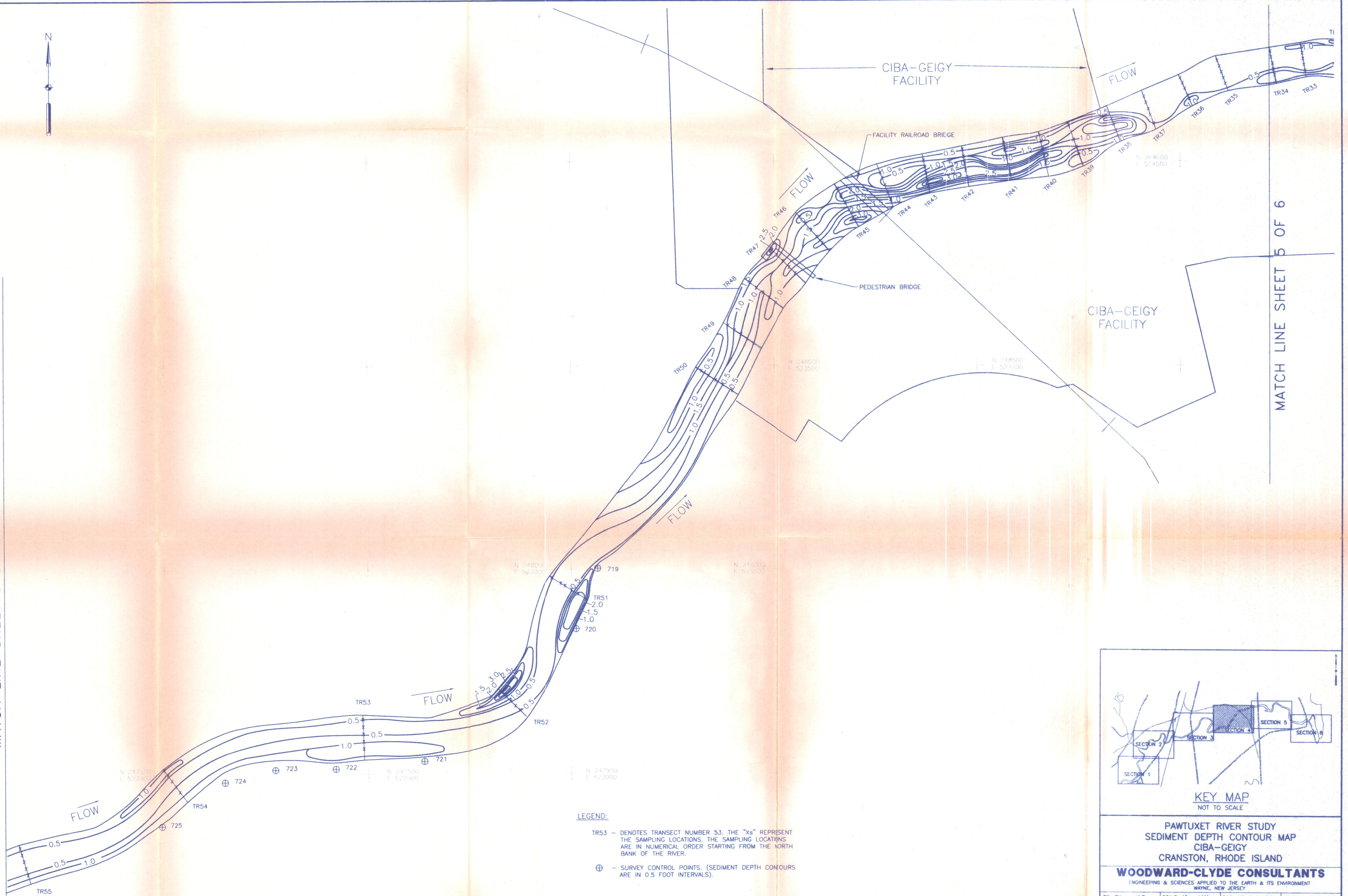
WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | | | | | |
|----------|-----|-------|--------------|----------|--------------|-----------|---------|
| DR. BY | MVB | SCALE | 1" = 100' | DWG. NO. | 74660088 | PROJ. NO. | 87X4660 |
| CK'D. BY | KAK | DATE | FEB 20, 1996 | FIG. NO. | 2-5 (3 OF 6) | | |

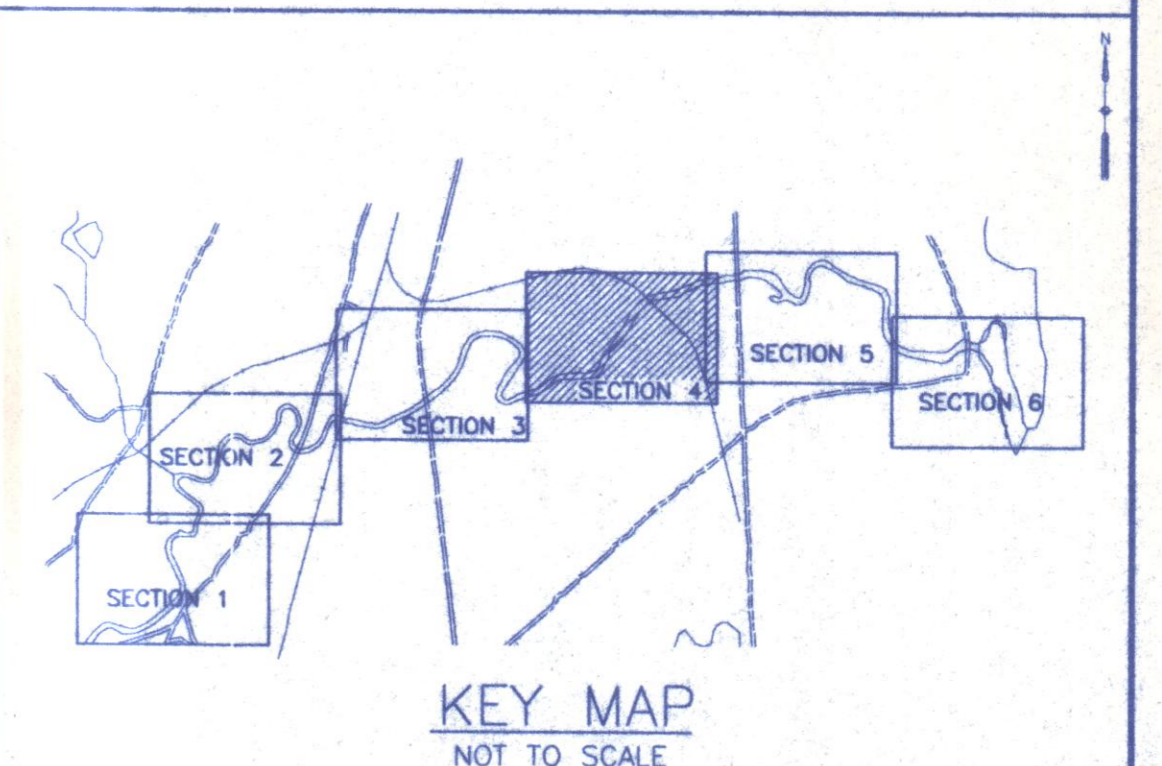
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MATCH LINE SHEET 3 OF 6



LEGEND:

- TR53 - DENOTES TRANSECT NUMBER 53. THE "x's" REPRESENT THE SAMPLING LOCATIONS. THE SAMPLING LOCATIONS ARE IN NUMERICAL ORDER STARTING FROM THE NORTH BANK OF THE RIVER.
- ⊕ - SURVEY CONTROL POINTS. (SEDIMENT DEPTH CONTOURS ARE IN 0.5 FOOT INTERVALS).



PAWTUXET RIVER STUDY
SEDIMENT DEPTH CONTOUR MAP
CIBA-GEIGY
CRANSTON, RHODE ISLAND

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | | | | | |
|-----------|-----|-------|--------------|----------|--------------|-----------|---------|
| DR. BY | MVB | SCALE | 1" = 100' | DWG. NO. | 74660089 | PROJ. NO. | 87X4660 |
| CHK'D. BY | KAK | DATE | FEB 20, 1996 | FIG. NO. | 2-5 (4 OF 6) | | |

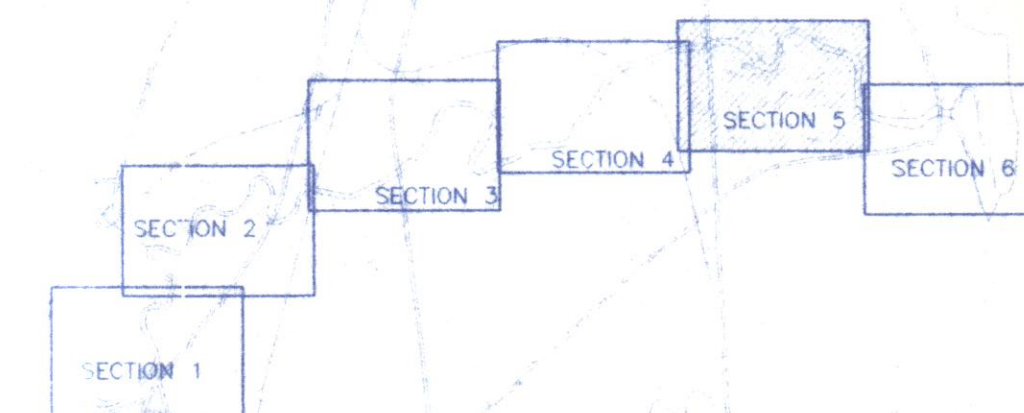
MATCH LINE SHEET 4 OF 6

WARWICK AVENUE

MATCH LINE SHEET 5 OF 6

LEGEND:

- TR53 - DENOTES TRANSECT NUMBER 53. THE "Xs" REPRESENT THE SAMPLING LOCATIONS. THE SAMPLING LOCATIONS ARE IN NUMERICAL ORDER STARTING FROM THE NORTH BANK OF THE RIVER.
- ⊕ - SURVEY CONTROL POINTS. (SEDIMENT DEPTH CONTOURS ARE IN 0.5 FOOT INTERVALS).



KEY MAP
NOT TO SCALE

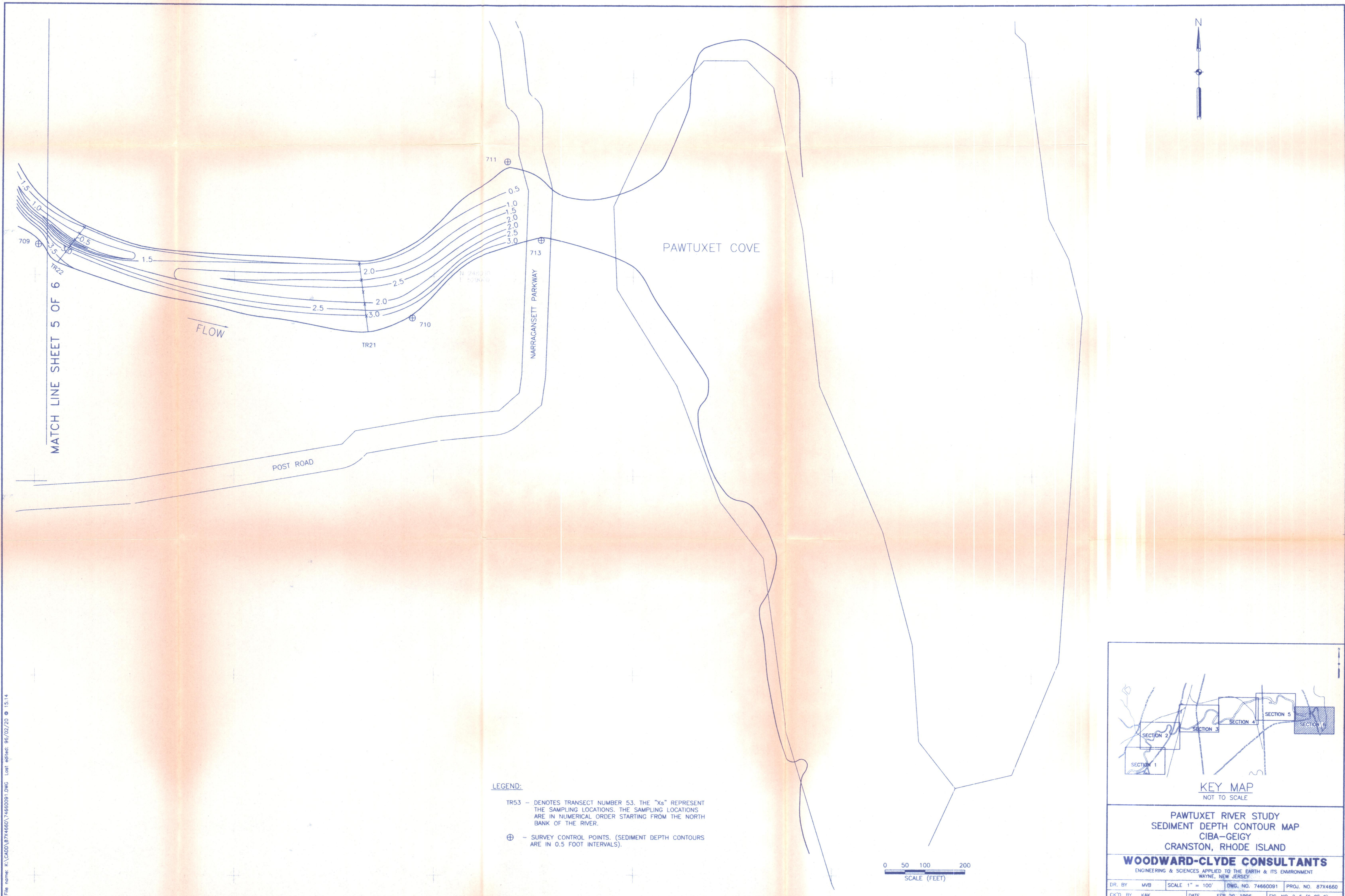
PAWTUXET RIVER STUDY
SEDIMENT DEPTH CONTOUR MAP
CIBA-GEIGY
CRANSTON, RHODE ISLAND

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | | | | | |
|----------|-----|-------|--------------|----------|--------------|-----------|---------|
| DR. BY | MVB | SCALE | 1" = 100' | DWG. NO. | 74660090 | PROJ. NO. | 87X4660 |
| DRAWN BY | KAK | DATE | FEB 20, 1996 | FIG. NO. | 2-5 (5 OF 6) | | |

File name: K:\CAD\87X4660\74660091.DWG Last edited: 96/02/20 @ 15:14



SOURCE CHARACTERIZATION

3.1 OVERVIEW

As required by the Order, the RCRA Facility Investigation Report On-Site Areas (submitted July 1995) provided a detailed evaluation of the SWMUs, AOCs and AAOIs at the Site. As part of this evaluation, a source characterization was performed. The source characterization summarized existing information on the SWMUs, AOCs, and AAOIs including - location, operating history, closure methods, and waste (if any) associated with these sources. The results of the *On-Site* source characterization were integrated into the Pawtuxet River RFI and used, in part, to help identify potential sources which may have impacted the river and to help design a comprehensive release characterization program for the river. This section presents a brief summary of the SWMUs, AOCs, and AAOIs, with more emphasis placed on those potential sources which may have impacted the Pawtuxet River. (The locations of the SWMUs, AOCs and AAOIs are shown on Figure 3-1 and summarized in Table 3-1.) Section 3.2 presents the source characterization results. A summary is presented in Section 3.3.

3.2 SOURCE CHARACTERIZATION RESULTS

Twelve solid waste management units (SWMUs) and two areas of concern (AOCs) were identified in the Order. For completeness of the study, Ciba identified two additional areas of investigation (AAOI-15 and AAOI-16). AAOI-16 was redesignated as SWMU-16 following the Phase I investigation. Detailed information about these SWMUs, AOCs, and AAOIs was presented in the RCRA Facility Investigation Report On-Site Areas.

The SWMUs, AOCs, and AAOIs identified at the Site are presented here by area and summarized in Table 3-1. The Production Area is presented first followed by the Waste Water Treatment Area and the Warwick Area.

3.2.1 Production Area

SWMU-2 is located in the former tank farm area where a 6,000 gallon above ground tank was used to store hazardous liquid waste containing acetone, toluene, monochlorobenzene, ethanol, isopropanol, naphthalite, xylene, heptane and methanol. No releases from this tank were known or suspected, so this SWMU is not suspected to have impacted the river.

SWMU-3 is located in the same former tank farm area as SWMU-2. SWMU-3 is the site where an above ground 7,500 gallon waste accumulation tank was located and was used to store flammable waste liquids for periods of less than 90 days. No releases from this tank were known or suspected, so this SWMU is not suspected to have impacted the river.

SWMU-4 is the site of a trash compactor station where packaging material, waste paper and washed fiber drums were handled. There were no known or suspected releases from this SWMU. Investigation of SWMU-4 was not required by the Order.

SWMU-7 is an area (about 10 feet wide, 200 feet long and 1 foot deep) where approximately 500 gallons of chlorosulfonic acid was spilled from a tank truck in 1961. The soils in the release area were neutralized and excavated for the tank farm foundations. The neutralizing agent used and the amount of soil removed is not known. This SWMU is not believed to have impacted the river.

SWMU-8 is an area where potassium ferrocyanide (Prussian Blue) is believed to have been spilled. At least 300 cubic yards of blue stained soil were removed from this area in 1961. This SWMU is not believed to have impacted the river.

SWMU-11 is the site of a subsurface sump from which waste water containing toluene was released. The sump was associated with Building 11 and had a capacity of 300 gallons. Ciba estimated that the toluene loss was between 9 and 90 pounds. Releases from SWMU-11 have impacted shallow groundwater in this area.

Laboratory analysis of the material spilled or the media impacted was not performed after the release. The influent to the waste water treatment plant typically contained halogenated and non-halogenated solvents and other organic compounds (e.g., materials routinely used in the chemical manufacturing process). The pH of the river both upstream and downstream of the spill's entry was measured to be 6 by Ciba personnel. The discharge pH was documented as ranging from 4 to 12. The spill resulted in a period of bypass as defined in the facility's NPDES permit. This SWMU is considered to be a potential source of contamination to the river.

SWMU-16 is the site of a maintenance department cleaning area located near the southwest corner of former Building 33. Production machinery (such as portable filters) was brought to this area and steam cleaned. Rinse water was not collected (or analyzed) and probably drained to the nearby catch basin drain system. The maintenance department cleaning area operated from the mid-1960's until 1986. The design and physical condition of the catch basin is unknown. The shallow groundwater in this area flows to the Pawtuxet River. This area was initially identified as an AAOI in the Current Assessment Summary Report and later reclassified as a SWMU because of the detection of contaminants in shallow groundwater during Phase I sampling. Shallow groundwater in this area flows toward the Pawtuxet River, so this SWMU may be a source of contamination to river water, sediment, and biota.

3.3 SUMMARY OF POTENTIAL SOURCES TO THE RIVER

The potential sources from onsite activities which may have impacted the Pawtuxet River include shallow groundwater migrating from the Production and Warwick Areas and historical releases of waste water from the Waste Water Treatment Area. Additionally, prior to 1975, process waste water was discharged to the cofferdam adjacent to the Production Area, sediments within this area may have provided a source of contamination prior to the voluntary sediment removal IRM conducted during the Winter of 1995.

Table

TABLE 3-1
SWMUs, AOCs, AND AAOIs

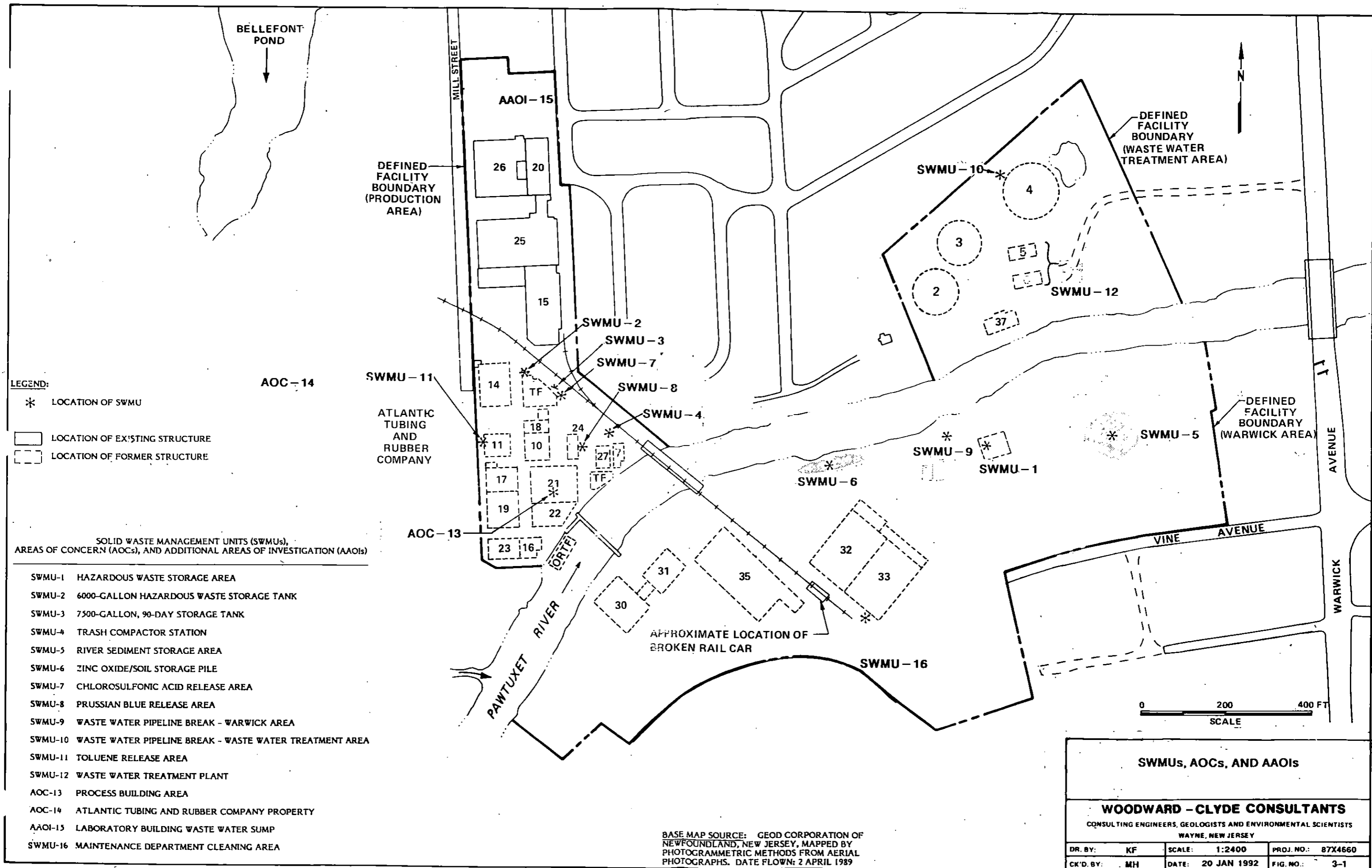
| <u>Number</u> | <u>Name</u> | <u>Study Area</u> | <u>Active Dates</u> | <u>Description</u> |
|---------------|---|-------------------|---------------------|--|
| SWMU-1 | Hazardous Waste Storage Area | Warwick | 1981 to 1986 | SWMU-1 was designed for a maximum capacity of 768 55-gallon drums. Typically, it stored 300 to 400 drums containing various wastes including flammable liquids and solids, corrosive liquids and solids, organic mixtures and solids, non-hazardous organic mixtures, and chloroform. The area was about 42 by 58 feet, and was asphalt-lined, diked, and surrounded by a 6-foot chain-link fence. The dike was capable of holding 48,000 gallons. |
| SWMU-2 | 6000-Gallon Hazardous Waste Storage Tank | Production | 1981 to 1986 | SWMU-2 was a carbon steel tank used to store process wastes containing acetone, toluene, monochlorobenzene, isopropanol, naphtha, xylene, heptane, methanol, and water. The tank was 17 feet high, 8 feet in diameter, and was enclosed by an 8000-gallon capacity dike (14.5 by 19 by 4 feet). |
| SMU-3 | 7500-Gallon 90-Day Storage Tank | Production | 1985 to 1986 | SWMU-3 was a vertical above-ground tank used to store flammable liquids for periods of less than 90 days. The stainless steel tank was 17 feet high, 8.5 feet in diameter, and was enclosed by a 25,000-gallon dike (about 28 by 29 by 4 feet). |
| SWMU-4 | Trash Compactor Station | Production | 1972 to 1986 | SWMU-4 had two trash compactors (30- and 55-cubic yard capacity) and only handled packaging material, paper wastes, and washed fiber drums. The trash compactor station (21 by 36 feet) was concrete-lined and drained to the Waste Water Treatment Plant. |
| SWMU-5 | River Sediment Storage Area | Warwick | 1971 to 1976 | SWMU-5 contained about 6630 cubic yards of sediment that had been dredged from the Pawtuxet River as part of removing the original cofferdam/waste water outfall. The sediment was removed from the Site in 1976; the area's natural grade was restored in 1977. |
| SWMU-6 | Zinc Oxide/Soil Storage Pile | Warwick | Late 1960s to 1995 | SWMU-6 had about 25 cubic yards of soil containing about 10% zinc oxide residue; the residue resulted from a broken railcar spill. The soil pile was about 50 feet long by 7 feet wide by 2 feet high. |
| SWMU-7 | Chlorosulfonic Acid Release Area | Production | 1961 | SWMU-7 was an area about 10 by 20 feet in which about 500 gallons of chlorosulfonic acid were released. |
| SWMU-8 | Prussian Blue Release Area | Production | 1956 | SWMU-8 was an area where about 300 cubic yards of blue-stained soil (believed to be stained by the release of an unknown quantity of Prussian Blue) was excavated and removed. |
| SWMU-9 | Waste Water Pipeline Break - Warwick Area | Warwick | 12 Jan. 1982 | SWMU-9 is where a break in the main raw waste transfer line resulted in the discharge of about 24,000 gallons of waste water. The waste water entered the surface water runoff catchment system and discharged to the Pawtuxet River. The waste water typically contained halogenated and non-halogenated solvents and other organic compounds routinely used in the chemical manufacturing process. |

| <u>Number</u> | <u>Name</u> | <u>Study Area</u> | <u>Active Dates</u> | <u>Description</u> |
|----------------------|---|---------------------------------|---------------------|--|
| SWMU-10 | Waste Water Pipeline Break - Waste Water Treatment Area | Waste Water Treatment | 7 Sept. 1983 | SWMU-10 is where a break in an underground waste water line resulted in a discharge of about 50,000 gallons. The discharge flowed into a small pond on-site and then diverted to the Pawtuxet River. The pH of the released waste water was 8.5; the chemical oxygen demand was 1010 parts per million. This discharge contained acetone (31 pounds), isopropyl alcohol (45 pounds), toluene (7 pounds), xylene (1.7 pounds), zinc (0.25 pounds), and nitrobenzene (0.125 pounds). |
| SWMU-11 | Toluene Waste Water Release Area | Production | 1983 | SWMU-11 is where an estimated release of between 9 and 90 pounds of toluene in waste water occurred via a subsurface sump associated with Building 11. |
| SWMU-12 | Waste Water Treatment Plant | Waste Water Treatment | 1970 to 1983 | SWMU-12 is the area formerly occupied by the Waste Water Treatment Plant. Biological trickling towers were used and periodic sump overflows from these towers resulted in discharges to the river. Influent to the towers routinely contained volatile and semi-volatile organic compounds. Additional releases from SWMU-12 in excess of the NPDES permit requirements have been reported for zinc, BOD, and phenols; in two releases, chloroform was discharged to the river. |
| AOC-13 | Process Building Area | Production | 1930 to 1986 | Area in which most of the production activities occurred. |
| AOC-14 | Atlantic Tubing and Rubber Company Property | Adjacent and west of Production | 1981 to present | This property was never used or developed by Ciba. |
| AAOI-15 ¹ | Laboratory Building Waste Water Sump | Production | 1961 to 1987 | The sump functioned as part of normal operations in the Laboratory Building. The gravity sump drained to sewer lines that discharged to the publicly owned treatment works. |
| SWMU-16 ² | Maintenance Department Cleaning Area | Warwick | mid-1960s to 1986 | Area where maintenance equipment was steam-cleaned. Rinse water drained to a nearby surface water catch basin. |

NOTES:

1. Ciba identified the two additional areas of investigation (AAOIs); no releases are known, but the potential for a release existed in the past.
2. Originally identified as AAOI-16 and redesignated as SWMU-16 following the Phase I investigation.

Figure



RELEASE CHARACTERIZATION

4.1 OVERVIEW

This section discusses the Pawtuxet River release characterization investigation. It is presented in five sections. The release characterization sampling strategy is given in Section 4.2. The surface water sampling methods, analyses, and results are discussed in Section 4.3. The sediment sampling methods, analyses, and results are discussed in Section 4.4. A statistical analysis is presented in Section 4.5. A summary of the release characterization is given in Section 4.6.

4.2 RELEASE CHARACTERIZATION SAMPLING STRATEGY

This section summarizes the release characterization sampling strategy for Phases I and II of the Pawtuxet River RFI.

4.2.1 Phase I Sampling Strategy

As required by the Order, two rounds of sediment and surface water sampling was completed in Phase I. The Phase I sampling strategy is presented here by reach - for the Upstream, Facility, and Downstream Reaches of the Pawtuxet River.

As discussed in Section 2, transects were established along the Pawtuxet River from the Cranston Gauge downstream to the Pawtuxet Cove Dam. Surveyor's stakes were driven into each riverbank to mark the transect endpoints for sampling and surveying. Each transect was divided into left, middle and right segments, facing upstream. Transect locations for the Phase I release characterization are shown on Figure 4-1. A summary of the transects established for Phase I for each of the river reaches is presented here.

Upstream Reach

Two upstream transects were established in Phase I. The far upstream transect (TR-00) was positioned to evaluate the river upstream of any effects from Mashapaug Brook. The near upstream transect (TR-01) was positioned to evaluate conditions just upstream of the Facility Reach, as well as, the potential effects of discharge to the river from Mashapaug Brook.

Facility Reach

Seven transects were positioned in the Facility Reach during Phase I to evaluate the potential effects of specific releases from the Site, based on the locations of known outfalls. Transect TR-02 was established to evaluate potential impacts from the former over-the-river tank farm (ORTF). TR-03 was positioned to assess the effect of the former cofferdam/wastewater outfall. TR-04 was positioned to fill the gap between the Production Area (TR-03) and the Waste Water Treatment Area. TR-05 was positioned to assess the potential impacts from Outfall 003 (in the Warwick Area). TR-06 was positioned to assess the potential impacts from Outfall 004. TR-07 was positioned to assess the potential impacts from Outfall 001. TR-08 was positioned slightly downstream of Outfall 005.

Downstream Reach

The Downstream Reach extends from the furthest downstream boundary of the facility to a meander bend in the river downstream near Rhodes-on-the-Pawtuxet. Five transects were positioned downstream to determine the impact, if any, of facility discharges downstream. Transects TR-09 and TR-10 were positioned just downstream of the Facility Reach. Transects 13, 16 and 20 were positioned further downstream to assess potential migration of contamination downstream.

4.2.2 Phase II Sampling Strategy

During Phase II, the results of the Phase I sediment analyses were reviewed along with the results of the physical characterization to determine Phase II sampling locations. This analysis indicated

that higher concentrations of most of the analytes detected were found in sediments with finer grained textures and higher total organic carbon content. Based on this observation, the criteria used to identify locations for sediment sampling during the Phase II release characterization included:

- 1) locations where fine-grained sediments were found during the physical characterization,
- 2) locations where TOC concentrations were higher during the physical characterization,
- 3) depositional zones,
- 4) locations that provide spatial representation of the reach, and
- 5) locations that were downstream of potentially significant sources of contamination.

For the Phase II release characterization, sampling transects were located in the Upstream, Upper Facility, Lower Facility and Downstream Reaches. A meeting was held between USEPA and CIBA-GEIGY to discuss the location of these transects and the plans for the Phase II sampling. An agreement was reached between USEPA and CIBA-GEIGY regarding the positioning of these transects and the sampling locations along each transect. The Phase II transect locations are shown on Figure 4-2.

Using these criteria, the results of the Phase II release characterization, discussed here, provide a "worst-case" scenario of the contaminant distribution in the river and ensure that the subsequent baseline ecological risk assessment is conservative in risk characterization of the Site.

Upstream Reach

Eight transects (TU1-TU8) were established during Phase II in the Upstream Reach to evaluate background conditions upstream of the Site.

Facility Reach

During Phase II, the Facility Reach was divided into two subreaches: the Upper Facility Reach (extending from the upstream boundary of the Facility Reach downstream about 600 feet to the downstream boundary of the Production Area), and the Lower Facility Reach (extending from the

downstream boundary of the Production Area downstream about 1,200 feet to the downstream boundary of the Facility). Ten transects were established in the Upper Facility Reach (TUF1-TUF10). Twelve transects were established in the Lower Facility Reach (TLF1-TLF12) for the Phase II sampling.

Downstream Reach

Four transects (TD1-TD4) were established during Phase II in the Downstream Reach.

4.3 SURFACE WATER SAMPLING METHODS, ANALYSES AND RESULTS

The surface water of the Pawtuxet River was sampled and analyzed for Appendix IX compounds and selected water quality parameters during the Phase I release characterization. Samples were collected during two rounds from the Upstream, Facility and Downstream reaches to evaluate the potential impact, if any, of past discharges from the facility on the river water. Round 1 surface water samples were collected in November 1990; Round 2 surface water samples were collected in March 1991.

4.3.1 Surface Water Sampling Methods and Analyses

Surface water samples were collected as dip samples at locations positioned along transects running perpendicular to river flow. Surface water samples were analyzed for Appendix IX compounds which included the following fractions: volatile organics, semi-volatile organics, polychlorinated biphenyls (PCBs), dioxin/furans, pesticides/herbicides, metals and cyanide.

4.3.2 Release Characterization Surface Water Results

This section presents the results of the surface water sampling that was conducted during Phase I. The results are presented by reach. A general discussion of the surface water results concludes this section.

Upstream Reach

A total of four surface water samples were collected from the Upstream Reach during Phase I. In both Round 1 and Round 2 one sample was collected from each transect (TR00 and TR01). The analytical results for the four surface water samples collected from the Upstream Reach are shown in Tables 4-1 and 4-2. Only those compounds that were detected in the surface water analyses are included in these tables.

Volatile Organic Compounds

Volatile organic compounds (chlorobenzene, m&p xylene, o-xylene and toluene) were measured in two of the four samples at concentrations ranging from 1 to 1.3 ppb.

Semi-Volatile Organic Compounds

Bis(2-ethylhexyl)phthalate, the only semi-volatile compound detected in the upstream river water samples, was measured in two samples at 7 ppb.

PCBs

No PCBs were detected in any of the upstream river water samples.

Pesticides and Herbicides

Methyl parathion was detected in one upstream river water sample at 0.02 ppb. No other pesticides or herbicides were detected in these samples.

Chlorinated Dioxins and Furans

No dioxins or furans were detected in any of the upstream river water samples.

Inorganics

For the inorganic compounds, barium, calcium, iron, magnesium, manganese, and sodium were detected in all four samples in the dissolved and total metal analyses. These elements are common constituents of natural surface waters. The range of these constituents is shown in Table 4-2.

Nickel was detected in two samples: one in dissolved form (at 20 ppb) and one in the total nickel analysis (at 26 ppb). Total zinc was measured in one sample (25 ppb) and dissolved potassium was measured in one sample (3,110 ppb). Lead was measured in the total metal analysis for all samples (from 3.5 to 23 ppb) and in dissolved form for one sample (at 5.1 ppb). Total cyanide was detected in two samples (from 11 to 19 ppb). No chromium or silver were measured in the upstream river water in dissolved or total form.

Summary of Upstream Surface Water Results

Low levels of volatile organic compounds (less than 2 ppb) and semi-volatile organic compounds (generally less than 8 ppb) were detected in surface water of the upstream reach. No PCBs or dioxins/furans were detected in the Upstream Reach surface water. One surface water sample contained a low concentration (0.02 ppb) of methyl parathion; no other pesticides/herbicides were detected.

Barium, calcium, iron, magnesium, manganese and sodium were detected in all upstream water samples in dissolved and total form as would be expected for natural surface waters. No chromium or silver was detected. Zinc (total at 25 ppb) and potassium (dissolved at 3,110) were measured in one sample each. Nickel was measured in two samples (total at 26 ppb and dissolved at 20 ppb). Lead was measured in total form in all samples (3.5 to 23 ppb) and in dissolved form for one sample (5.1 ppb).

Facility Reach

A total of seven surface water samples were collected from the Facility Reach in Phase I. In Round 1, one sample was collected at each of three transects (TR-03, TR-07 and TR-08) and two samples

(including a duplicate) were collected at transect TR-06. In Round 2, two samples (including a duplicate) were collected at transect TR-04. The analytical results for the five surface water samples collected from the Facility Reach are shown in Tables 4-3 and 4-4. Only those compounds that were detected in the surface water analyses are included in these tables.

Volatile Organic Compounds

Volatile organic compounds were detected in all five river water samples, ranging in total concentration from 0.5 to 4 ppb. The analytes detected were the same as in the Upstream Reach (chlorobenzene, toluene, o- and m&p-xylene), with the addition of chloroform.

Semi-Volatile Organic Compounds

The only semi-volatile organic compound detected was bis(2-ethylhexyl)phthalate which was measured in 4 of the 5 samples at concentrations of 1 to 5 ppb.

PCBs

No PCBs were detected in the Facility Reach river water.

Pesticides and Herbicides

Four organochlorine pesticides (4,4'-DDE 4,4'-DDT, beta-BHC, and dieldrin) and three organophosphorous pesticides (disulfoton, ethyl parathion, and famphur) were detected in four of the five samples at concentrations from 0.0077 to 0.073 ppb. No herbicides were detected in these samples.

Chlorinated Dioxins and Furans

No dioxins or furans were detected in the Facility Reach river water.

Inorganics

For the inorganic analytes, dissolved and total concentrations of barium, calcium, iron, magnesium, manganese and sodium were measured in all samples, as in the Upstream Reach. These elements are common constituents of natural surface waters. The concentrations measured for these compounds are shown in Table 4-4.

Total chromium was not detected in any samples. Nickel was measured in dissolved and total form in three of the five samples at concentrations ranging from 20 to 32 ppb. Dissolved and total potassium were measured in four samples at concentrations ranging from 3,000 to 3,430 ppb. Silver was detected in one sample in total form at 37 ppb. Zinc was detected in two of the five samples, in dissolved form, at concentrations ranging from 31 to 40 ppb. Total lead was detected in four samples and dissolved in three at concentrations ranging from 3.2 to 13 ppb. Total cyanide was measured in four of the five samples at concentrations ranging from 10 to 14 ppb.

Summary of Facility Surface Water Results

Low levels of volatile organic compounds (less than 7 ppb) and semi-volatile organic compounds (less than 6 ppb) were detected in surface water of the Facility Reach. No PCBs or dioxins/furans were detected in the Facility Reach surface water. Four pesticides (beta-BHC, dieldrin, 4,4'-DDE and 4,4'-DDT) were measured at low concentrations (less than 0.25 ppb). No herbicides were measured in these samples.

Barium, calcium, iron, magnesium, manganese and sodium were measured in all samples, as in the Upstream Reach. Chromium was not detected in any samples. Dissolved zinc was measured in two samples (31 and 40 ppb). Total silver was measured in one sample (37 ppb). Dissolved and total potassium were measured in four samples (3,000 - 3,430 ppb). Dissolved and total nickel were measured in three samples (20 - 32 ppb). Lead was detected in every sample in either dissolved and/or total form at concentrations ranging from 3.2 to 13 ppb. Cyanide was measured in four of the 5 samples at concentrations ranging from 10 to 14 ppb.

Downstream Reach

Six surface water samples were collected from the Downstream Reach in Phase I. In Round 1, a sample was collected at each of three transects (TR-09, TR-10 and TR-20). A fourth sample was collected later at TR-09 during bioassay sampling. In Round 2, two more samples were collected at TR-09 and TR-20. The results of the surface water analyses for the Downstream Reach are shown in Tables 4-5 and 4-6. Only those compounds that were detected in the surface water analyses are included in these tables.

Volatile Organic Compounds

Volatile organic compounds (chlorobenzene, chloroform, iodomethane, o-xylene, m&p-xylene, and toluene) were detected in five of the six river water samples from the Downstream Reach, ranging in concentration from 0.7 to 2.0 ppb. All of the volatile organic compounds detected in the Upstream and Facility Reaches were also detected in the Downstream Reach.

Semi-volatile Organic Compounds

Bis(2-ethylhexyl)phthalate was detected in three of the six downstream samples in concentrations ranging from 1 to 4 ppb. Di-n-octyl-phthalate was detected in one sample at 10 ppb. No other semi-volatile compounds were detected in the Downstream Reach.

PCBs

No PCBs were detected in any downstream river water samples.

Pesticides and Herbicides

Three organochlorine pesticides (4,4'-DDE, 4,4'-DDT and beta-BHC) were detected in two of the six Downstream Reach river water samples at concentrations ranging from 0.0065 to 0.052 ppb. Three organophosphorous pesticides (dimethoate, disulfoton, and methyl parathion) were detected

in three of the samples at concentrations ranging from 0.02 to 0.18 ppb. No herbicides were detected.

Dioxins and Furans

No dioxins or furans were detected in any downstream surface water samples.

Inorganics

As in the Upstream and Facility Reaches, dissolved and total concentrations of barium, calcium, iron, magnesium, manganese, and sodium were measured in all samples from the Downstream Reach as shown in Table 4-6. Nickel was measured in dissolved form in three samples (from 27 to 31 ppb) and in total form in two samples (from 26 to 27 ppb). Potassium was measured in dissolved and total form in three of the six samples (from 3,170 to 3,560 ppb). No silver was measured in any river water samples from the Downstream Reach. Zinc was measured in dissolved form in three samples (from 46 to 58 ppb) and in total form in one sample (at 31 ppb). Lead was measured in total form in five samples (from 3.4 to 10 ppb) and dissolved form in three samples (from 4.4 to 6.7 ppb). Total cyanide was measured in three of the six samples at concentrations ranging from 12 to 20 ppb

Summary of Downstream Surface Water Results

Low levels of volatile organic compounds (less than 3.0 ppb) and semi-volatile organic compounds (less than 15 ppb) were detected in the Downstream Reach surface water. No PCBs or dioxins/furans were detected in these samples. Low levels of pesticides were detected in the downstream river water (less than 0.6 ppb).

As in the Upstream and Facility Reaches, barium, calcium, iron, magnesium, manganese and sodium were measured in all water samples in the Downstream Reach in dissolved and total form. Lead was measured in total form in five samples (from 3.4 to 10 ppb) and dissolved form in three samples (from 4.4 to 6.7 ppb). Nickel was measured in dissolved form in three samples (from 27 to 31 ppb) and in total form in two samples (from 26 to 27 ppb). Potassium was measured in

dissolved and total form in three of the six samples (from 3,170 to 3,560 ppb). Zinc was measured in dissolved form in three samples (from 46 to 58 ppb) and in total form in one sample (at 31 ppb). No silver was measured in any river water samples from the Downstream Reach. Total cyanide was measured in three of the six samples at concentrations ranging from 12 to 20 ppb.

4.3.3 Discussion of Surface Water Results

The analytical results of Pawtuxet River water from the Upstream, Facility and Downstream Reaches were comparable. In general, the same organic analytes tended to be detected in all three reaches. No PCBs, dioxins or furans were detected in any samples. Across all three reaches, the mean total concentrations of volatile organic compounds ranged from 1.25 ppb (Upstream Reach) to 2.8 ppb (Facility Reach). The mean total concentrations of pesticides/herbicides ranged from 0.005 ppb (Upstream Reach) to 0.12 ppb (Downstream Reach).

For the inorganic analytes, barium, calcium, iron, magnesium, manganese and sodium were detected in all samples. These elements are common constituents of natural waters. Lead, nickel, potassium, zinc and cyanide were all detected in upstream surface water samples, as well as in the facility and downstream samples. Silver was only detected in one water sample, from the upstream end of the Facility Reach. In general, the pattern of occurrence of inorganic analytes in the river water is similar for all three reaches.

The limited number of analytes detected and the small ranges of concentrations of these analytes suggest that the Pawtuxet River surface water is comparable across all three reaches investigated. These results do not indicate that releases from the facility have affected Pawtuxet River surface water quality. Based on these results, no additional surface water sampling was conducted during subsequent phases of the Pawtuxet River RFI.

4.4 RIVER SEDIMENT SAMPLING METHODS, ANALYSES AND RESULTS

The specific objectives for the release characterization of Pawtuxet River sediments were:

- To determine the nature and extent of contamination in river sediments; and

- To determine if releases from the facility are impacting sediments in the river.

This section summarizes the release characterization sediment sampling methods, analyses and results.

4.4.1 Sediment Sampling Methods and Analyses

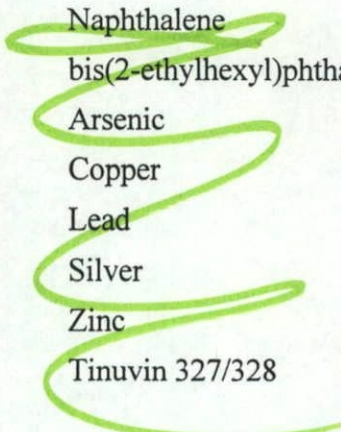
As specified in the Order, sediment was sampled in both phases of the release characterization. In each phase, two rounds of sediment sampling were performed. During the second round of sampling (in both phases), selected locations sampled during Round 1 were re-sampled to provide verification of Round 1 results.

Surface sediment (0 to 6 inch depth interval) was sampled from the Upstream and Downstream Reaches. In the Facility Reach, sediment was sampled from three depth intervals during the release characterization: surface sediments were sampled from the 0-6 inch depth interval, shallow sediments were collected from the 1-2 foot depth and deep sediments were sampled below 2 feet. The subsurface sediments were collected to characterize the vertical distribution of contamination within areas where surface sediments contained elevated concentrations of contaminants.

Surface samples were collected using a grab sampler, such as a ponar sampler. Subsurface samples were collected using coring devices.

Phase I sediment samples were analyzed for Appendix IX compounds and fingerprint compounds. Fingerprint compounds are specific chemicals unique to the activities at the former Ciba facility in Cranston, Rhode Island. From this extensive list of compounds, a reduced list of compounds was selected by USEPA and Ciba for analysis of sediments collected during the Phase II release characterization. This reduced list of compounds is referred to as the "Phase II Analytes" in this report. The Phase II Analytes included:

PCBs
Chlorobenzene
Toluene



Naphthalene
bis(2-ethylhexyl)phthalate
Arsenic
Copper
Lead
Silver
Zinc
Tinuvin 327/328

In addition, selected sediment samples were analyzed for dioxin/furans during Phase II.

4.4.2 Release Characterization Sediment Results

The results of the Phase I Appendix IX sediment analyses were presented in the Phase I Interim Report (CIBA-GEIGY, 1991). The rationale for selecting the List of Phase II Analytes was discussed in the Revisions to the Phase II Pawtuxet River Proposal (CIBA-GEIGY, 1993). This report summarizes the results of the sediment analyses from Phases I and II by reach. The Upstream Reach is discussed first, and is followed by the Upper Facility, Lower Facility, and Downstream Reaches.

Upstream Reach

Four sediment samples were collected from the Upstream Reach during Round 1 of Phase I. Nine samples, including one duplicate, were collected from the Upstream Reach during Phase II. All sediment samples collected were surface sediments (sampled from the top six inches of sediment). The results of the organic analyses for the Upstream Reach sediment is presented in Table 4-7. Sediment sample locations are shown on Figure 4-3.

Volatile Organic Compounds

Toluene and acetone were the most frequently detected volatile organic compounds in upstream sediments, occurring in about one third of the samples at concentrations ranging from 0.0063 to

0.78 ppm and 0.081 to 0.4 ppm, respectively. M&p-xylene was detected in two samples with concentrations ranging from 0.007 to 0.021. Chlorobenzene (0.64 ppm), o-xylene (0.07 ppm), 2-butanone (0.58 ppm) and 2-hexanone (0.25 ppm) were all detected in one sample only.

Semi-volatile Organic Compounds

The following semi-volatile organic compounds were measured in most of the upstream samples: anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-CD)pyrene, phenanthrene, pyrene and bis(2-ethylhexyl)phthalate. Concentrations of these semi-volatile organic compound ranged from 0.022 to 10 ppm. Dibenz(a,h)anthracene, fluorene and di-n-octylphthalate were measured in about one third of the samples at concentrations ranging from 0.064 - 0.92 ppm. Acenaphthene, acenaphthalene, 2-methylnaphthalene, naphthalene, butylbenzylphthalate, di-n-butylphthalate, 1-2-dichlorobenzene, 4-chloraniline, 3&4-methylphenol, 4-methylphenol and 5-nitro-o-toluidine were measured in less than twenty-five percent of the samples at concentrations ranging from 0.03 - 9.9 ppm.

PCBs

No PCBs were detected in upstream sediments.

Pesticides and Herbicides

No herbicides or organophosphorus pesticides were detected in upstream sediments. Of the organochlorine pesticides, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha-chlordane and gamma-chlordane were measured in over half of the samples at concentrations ranging from 0.00063 - 0.045 ppm. Aldrin, beta-BHC, chlorobenzilate, dieldrin, endosulfan (I, II and sulfate), endrin, endrin aldehyde, gamma-BHC, heptachlor epoxide and kepone were measured in less than half of the samples at concentrations ranging from 0.0005 - 0.077 ppm.

Dioxins and Furans

Nine upstream samples were analyzed for dioxins and furans. OCDD was detected in seven of the upstream sediment samples at concentrations ranging from 0.00013 to 0.0017 ppm. Dibenzofuran (0.12 ppm), TRCDF (0.43 ppm), 1,2,3,4,6,7,8-HPCDD (0.00018 ppm) and HPCDD (0.00036) were each detected in one sample.

Fingerprint Compounds

Tinuvin 327/328 was not detected in any upstream samples.

Inorganics

The results of the inorganic analyses for the Upstream Reach sediment are presented in Table 4-8. Barium (9.9 - 97.6 ppm), chromium (9.6 - 2,190 ppm), cobalt (1.4 - 8.3 ppm) copper (9 - 164 ppm), vanadium (2.2 - 14.9 ppm), zinc (22.3 - 452 ppm) and lead (11 - 745 ppm) were detected in all sediments collected from the Upstream Reach. Beryllium (0.42 - 2.2 ppm), cadmium (0.8 to 2.2 ppm), nickel (4.8 - 30.3 ppm), arsenic (1.6 to 29.5 ppm), mercury (0.05 - 5.6 ppm) and sulfide (53.7 - 1,600 ppm) were measured in over half of the upstream samples. The following inorganics were measured in less than half of the samples: calcium (497 - 2,490 ppm), iron (4,770 - 15,800 ppm), magnesium (908 - 2,180 ppm), manganese (88.3 - 344 ppm), potassium (300 - 1,440 ppm), sodium (145 - 446 ppm), tin (8.9 - 113 ppm), selenium (0.325 - 1.08 ppm), thallium (0.325 - 1.08 ppm) and cyanide (8.5 - 20.5 ppm). Antimony was detected in one sample at 0.96 ppm.

Upper Facility Reach

Nine samples, including one duplicate, were collected during each round of sampling in Phase I, resulting in a total of eighteen (18) samples collected from the Facility Reach. Three surface sediment samples were collected in Phase II. This depth fraction had been extensively sampled in this area during previous phases of the investigation. In addition, thirty-two shallow sediment

samples (including three duplicates) and sixteen deep sediment samples were collected in the Upper Facility Reach during Phase II. Sediment sample locations are shown on Figure 4-4.

Surface Sediment

Volatile Organic Compounds

The results of the organic analyses for the Upper Facility Reach surface sediment are presented in Table 4-9. Chlorobenzene and toluene were detected in over half of these samples at concentrations ranging from 0.063 to 430 ppm and from 0.035 to 860 ppm, respectively. M&p-xylene and o-xylene were detected in two samples each at concentrations ranging from 0.059 to 8.2 ppm. Benzene (0.086 ppm) and ethylbenzene (0.061 ppm) were detected in one sample, 2-butanone (0.74 ppm), 2-hexanone (0.38 ppm), 4-methyl-2-pentanone (0.26 ppm) and acetone (0.64 ppm) were detected in another sample.

Semi-volatile Organic Compounds

The following semi-volatile organic compounds were measured in about half of the samples: anthracene (0.052 - 0.93 ppm), benzo(a)anthracene (0.26 - 3.8 ppm), benzo(a)pyrene (1.4 - 4.1 ppm), benzo(b)fluoranthene (0.44 - 8.9 ppm), benzo(g,h,i)perylene (1.7 - 4.8 ppm), benzo(k)fluoranthene (0.46 - 9.3 ppm), chrysene (0.31 - 6.9 ppm), fluoranthene (0.48 - 14 ppm), fluorene (0.13 - 0.79 ppm), indeno(1,2,3-cd)pyrene (1.4 - 4.3 ppm), 2-methylnaphthalene (0.44 - 4.7 ppm), phenanthrene (0.19 - 6.2 ppm), pyrene (0.46 - 11 ppm), bis(2-ethylhexyl)phthalate (0.46 to 110 ppm) and 1,2-dichlorobenzene (0.22 - 4.6 ppm). The following semi-volatile organic compound were detected in less than half of the samples: acenaphthene (0.18 - 0.36 ppm), acenaphthylene (0.089 - 0.11 ppm), dibenz(a,h)anthracene (0.62 - 1.5 ppm), naphthalene (0.68 - 100 ppm), di-n-octylphthalate (1.6 - 5 ppm), 1,4-dichlorobenzene (0.59 - 2.8 ppm), 4-chloroaniline (7.8 - 32 ppm) and 4-methylphenol (0.64 - 4 ppm). Di-n-butylphthalate (8.7 ppm), dimethylphthalate (290 ppm), 1,2,4-trichlorobenzene (0.4 ppm), 1,3-dichlorobenzene (0.69 ppm), 2-methylphenol (3.3 ppm), and pentachlorophenol (12 ppm) were detected in one sample.

PCBs

Aroclors 1221, 1232 and 1242 were not detected in surface sediments. Aroclor 1248 was detected in two samples at concentrations of 0.62 and 390 ppm. Aroclor 1254 was detected in three samples at concentrations ranging from 6.2 to 260 ppm. Aroclor 1260 was only detected in one sample at 0.021 ppm. Summing all the detected values of individual Aroclors to calculate total PCBs resulted in detected concentrations ranging from 0.021 to 650 ppm.

Pesticides and Herbicides

Only the surface sediment samples were analyzed for pesticides/herbicides. The following pesticides/herbicides were measured in one or two of these samples at concentrations less than 1.0 ppm: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha-BHC, alpha-chlordane, dieldrin, endrin, gamma-BHC, gamma-chlordane, heptachlor and 2,4-D.

Dioxins and Furans

Dibenzofuran and DCDF were detected in surface sediments of the Upper Facility Reach. Dibenzofuran was detected four times at concentrations ranging from 0.23 to 0.32 ppm. DCDF was detected in one sample at a concentration of 0.5 ppm.

Fingerprint Compounds

Tinuvin 327 was detected in three samples at concentrations ranging from 0.8 to 2,200 ppm. No Tinuvin 328 was detected in the surface sediments.

Inorganics

The results of the inorganic analyses for the Upper Facility Reach surface sediment are presented in Table 4-10. Copper, zinc, arsenic and lead were detected in all surface sediment samples. Copper concentrations ranged from 15.1 to 1,080 ppm. Concentrations of zinc ranged from 45.4 to 13,900

ppm. Arsenic concentrations ranged from 1.8 to 38.2 ppm. Lead concentrations ranged from 14.1 to 829 ppm. The following metals were measured in fifty to seventy-five percent of the surface sediments: barium (19.3 - 380 ppm), beryllium (0.5 - 4.2 ppm), cadmium (0.72 - 22 ppm), calcium (691 - 5,720 ppm), chromium (13.9 - 1,260 ppm), cobalt (2.3 - 11 ppm), iron (6,010 - 27,700 ppm), magnesium (898 - 3,950 ppm), manganese (93.9 - 574 ppm), nickel (27.1 - 166 ppm), potassium (599 - 2,040 ppm), sodium (544 - 952 ppm), vanadium (3.5 - 49.4 ppm), mercury (0.25 - 2.8 ppm) and cyanide (2.8 - 31.4 ppm). The following metals were measured in less than half of the samples: antimony (1.6 - 6.9 ppm), silver (2.3 - 17.1 ppm), tin (25.6 - 75.2 ppm), selenium (0.802 - 1.16 ppm), thallium (0.802 - 1.16 ppm) and sulfide (49 - 17,000 ppm).

Shallow Sediment

The shallow sediment samples in the Upper Facility Reach were analyzed for the short list of Phase II Analytes. This list includes two semi-volatile compounds: bis(2-ethylhexyl)phthalate and naphthalene (sometimes analyzed as a volatile organic compound).

Volatile Organic Compounds

The results of the organic analyses for the Upper Facility Reach shallow sediment is presented in Table 4-11. Chlorobenzene was detected in 16 samples at concentrations ranging from 0.0072 to 1,900 ppm. Naphthalene, measured as a volatile organic constituent, was detected in five samples at concentrations ranging from 0.0086 to 110 ppm.. Toluene was detected in two samples at 48 and 870 ppm.

Semi-volatile Organic Compounds

Bis(2-ethylhexyl)phthalate was detected in seventeen samples at concentrations ranging from 0.079 to 60 ppm. Naphthalene was not detected.

PCBs

The highest concentrations of PCBs measured during the release characterization occurred in this depth interval of the Upper Facility Reach. One sample contained 56 ppm of Aroclor 1221. Three samples contained Aroclor 1242 at concentrations ranging from 0.12 to 2 ppm. Aroclor 1248 was detected in fourteen samples; nine of the fourteen samples had concentrations of less than 1 ppm. In one sample, Aroclor 1248 was detected at a concentration of 34,000 ppm. Fourteen samples contained detectable concentrations of Aroclor 1254, ranging in concentration from 0.019 to 14 ppm. Aroclor 1260 was detected in seven samples at concentrations ranging from 0.021 to 5 ppm. No Aroclor 1232 was detected.

Dioxins and Furans

Nine of the shallow sediment samples were analyzed for dioxins and furans. Two forms of dioxin were detected in the shallow sediment samples: HPCDD and OCDD. HPCDD was detected in three samples at concentrations ranging from 0.00024 ppm to 0.00049 ppm. OCDD was detected in six samples at concentrations ranging from 0.00015 to 0.0028 ppm. Three forms of furans were also detected: HPCDF, HXCDF and OCDF. HPCDF was detected in six samples at concentrations ranging from 0.00013 to 0.00073 ppm. HXCDF was detected in four samples at concentrations ranging from 0.00012 to 0.00021 ppm. OCDF was detected in six samples at concentrations ranging from 0.0001 to 0.00058 ppm.

Fingerprint Compounds

Tinuvin 328 was measured in five samples at concentrations ranging from 0.31 - 110 ppm.

Inorganics

The results of the inorganic analyses for the Upper Facility Reach shallow sediment is presented in Table 4-12. The shallow sediment samples were analyzed for the short list of Phase II analytes, so sediments were only analyzed for five inorganic compounds.

Eight samples contained detectable concentrations of copper (12.5 - 267 ppm), zinc (15.15 - 1,540 ppm) and arsenic (2.4 - 8.6 ppm). Three samples contained silver (0.7 - 0.8 ppm) and lead (37.5 - 144 ppm) in concentrations above the detection limits.

Deep Sediment

Volatile Organic Compounds

The results of the organic analyses for the Upper Facility Reach deep sediment is presented in Table 4-13. Chlorobenzene was detected in five samples at concentrations ranging from 0.028 to 13,000 ppm. Toluene was detected in three samples at concentrations ranging from 0.009 to 3,500 ppm. Naphthalene, measured as a volatile organic constituent, was detected in two samples at 0.01 and 0.027 ppm.

Semi-volatile Organic Compounds

Bis(2-ethylhexyl)phthalate was detected in nine samples at concentrations ranging from 0.034 to 440 ppm.

PCBs

Aroclors 1248, 1254 and 1260 were detected in the deep sediments. Seven samples contained Aroclor 1248 at concentrations ranging from 0.013 to 5,400 ppm. Aroclor 1254 was detected in three samples at concentrations ranging from 0.049 to 0.14 ppm. Aroclor 1260 was detected in two samples at 0.14 ppm and 0.16 ppm. Total PCB concentrations ranged from 0.013 to 5,400 ppm in the deep sediments.

Dioxins and Furans

Two of the deep sediment samples were analyzed for dioxins and furans. Two forms of dioxin and three forms of furan were detected in one sample from the deep sediments: HPCDD at 0.0076

ppm, OCDD at 0.038 ppm, HPCDF at 0.008 ppm, HXCDF at 0.00042 ppm and OCDF at 0.00038 ppm.

Fingerprint Compounds

Tinuvin 328 was measured in two samples at 2.3 and 890 ppm.

Inorganics

The results of the inorganic analyses for the Upper Facility Reach deep sediment is presented in Table 4-14. Copper was detected in 14 samples at concentrations ranging from 0.257 to 184 ppm. Zinc was detected in 11 samples. Concentrations of zinc ranged from 12.4 to 1,610 ppm. Arsenic was detected in 15 samples at concentrations ranging from 1.4 to 45.2 ppm. Lead was detected in 11 samples at concentrations ranging from 1.3 to 272 ppm.

Lower Facility Reach

Twenty-five samples, including one duplicate, were collected from the top six inches of sediment in the Lower Facility Reach during Phase II. In addition, at one sample point (LF-12C), a deep core was collected providing a sample at 1-2 feet and 2-4 feet. Sediment sample locations are shown on Figure 4-4.

Volatile Organic Compounds

The results of the organic analyses for the Upper Facility Reach surface sediment is presented in Table 4-15. Chlorobenzene was detected in 8 samples at concentrations ranging from 0.0066 to 0.26 ppm. Toluene was detected in 5 samples at concentrations ranging from 0.0065 to 0.58 ppm. Naphthalene, measured with the volatile organic compounds, ranged from 0.012 to 0.041 ppm in three samples.

Semi-volatile Organic Compounds

Bis(2-ethylhexyl)phthalate was detected in 19 samples at concentrations ranging from 0.3 to 90 ppm. Naphthalene, measured as a semi-volatile organic compound, was detected in two samples at 0.17 to 0.21 ppm. The following - were measured in less than 25% of the samples: anthracene (0.048 - 0.33 ppm), benzo(a)anthracene (0.28 - 2.1 ppm), benzo(a)pyrene (0.27 - 2.2 ppm), benzo(b)fluoranthene (0.32 - 4.6 ppm), benzo(g,h,i)perylene (0.3 - 2.2 ppm), benzo(k)fluoranthene (0.36 - 5.1 ppm), chrysene (0.37 - 3.4 ppm), dibenz(a,h)anthracene (0.14 - 0.34 ppm), fluoranthene (0.6 - 8.2 ppm), fluorene (0.035 - 0.22 ppm), indeno(1,2,3-cd)pyrene (0.24 - 2 ppm), phenanthrene (0.28 - 2.2 ppm), pyrene (0.4 - 2.6 ppm), and di-n-butylphthalate (0.023 - 0.044 ppm).

PCBs

PCBs were detected in 18 of the 33 sediment samples collected from the Lower Facility Reach. Although Aroclors 1221, 1232, 1248, 1254 and 1260 were detected, Aroclors 1254 and 1248 were the most common. No samples contained detectable concentrations of Aroclors 1016 or 1242. Aroclor 1221 was detected in three samples at concentrations ranging from 0.064 to 7.9 ppm. Aroclor 1232 was detected in three samples, ranging in concentration from 0.053 to 0.4 ppm. Aroclor 1248 was detected in 15 samples at concentrations ranging from 0.017 to 2.2 ppm. Concentrations of Aroclor 1254 ranged from 0.039 to 1.4 ppm in 17 samples. Aroclor 1260 was detected in 4 samples at concentrations ranging from 0.017 to 0.087 ppm. Summing the detected Aroclors to calculate total PCBs, the concentrations ranged from 0.017 to 11.5 ppm for the Lower Facility Reach.

Pesticides and Herbicides

The following pesticides were detected in about 10% of the samples: 4,4'-DDT, aldrin, dieldrin, gamma-bhc, gamma-chlordane, heptachlor, disulfoton and methyl parathion. All concentrations were less than 0.13 ppm. Of the herbicides analyzed, 2,4-D and dinoseb were measured in one sample each at concentrations less than 0.05 ppm.

Dioxins and Furans

Thirteen sediment samples from the Lower Facility Reach were analyzed for dioxins and furans. Two forms of dioxin were detected: HPCDD and OCDD. The HPCDD was detected in one sample at 0.000066 ppm. OCDD concentrations ranged from 0.0004 to 0.00077 ppm in seven samples. Three forms of furans were detected in two samples in the Lower Facility Reach: HPCDF at 0.001 and 0.00061 ppm, HXCDF at 0.00071 and 0.00033 ppm and OCDF at 0.0002 and 0.00033 ppm.

Fingerprint Compounds

Tinuvin 327 was detected in two samples at 0.22 and 0.23 ppm. Tinuvin 328 was detected fifteen times at concentrations ranging from 0.161 to 27 ppm.

Inorganics

The results of the organic analyses for the Lower Facility Reach deep sediment is presented in Table 4-16. Copper, zinc, arsenic and lead were detected in almost all sediments collected from the Lower Facility Reach. The copper concentrations ranged from 6.2 to 226 ppm, the zinc concentration ranged from 19.8 to 370 ppm, the arsenic concentration ranged from 1.3 to 18.3 ppm and the lead concentration ranged from 1.2 to 200 ppm. The following metals were detected in less than one-fourth of the samples: barium (14.7 - 150 ppm), beryllium (0.49 - 2.9 ppm), cadmium (0.94 - 13.5 ppm), calcium (522 - 3,070 ppm), chromium (14.6 - 81.7 ppm), cobalt (1.8 - 12.8 ppm), iron (4,570 - 21,900 ppm), magnesium (734 - 2,460 ppm), manganese (74.2 - 621 ppm), nickel (5.3 - 58.9 ppm), potassium (269 - 1,630 ppm), silver (1.2 to 3.3 ppm), sodium (124 - 502 ppm), vanadium (2.1 to 20.7 ppm), mercury (0.091 - 0.35 ppm), selenium (0.424 - 1.27 ppm), thallium (0.424 - 1.27 ppm), cyanide (1.1 - 1.3 ppm) and sulfide (45 - 720 ppm).

Downstream Reach

Seven sediment samples were collected from the Downstream Reach in Phase I - three in Round 1 and four in Round 2. Eight surface sediment samples were collected during Phase II from the

Downstream Reach. The results of the organic analyses for the Downstream Reach surface sediment is presented in Table 4-17. Sediment sample locations are shown on Figure 4-5.

Volatile Organic Compounds

Chlorobenzene was detected in one-third of the samples at concentrations ranging from 0.016 to 21 ppm. Toluene was detected in 4 samples at concentrations ranging from 0.021 to 6.1 ppm. Naphthalene, measured as a volatile organic constituent, was detected in two samples at 0.015 to 2.4 ppm. 2-Butanone was measured in three samples at concentrations ranging from 0.13 to 0.2 ppm.

Semi-volatile Organic Compounds

Bis(2-ethylhexyl)phthalate was detected in 11 samples at concentrations ranging from 0.84 to 16 ppm. Naphthalene, measured as a semi-volatile organic constituent, ranged in concentration from 0.061 to 0.23 ppm in 3 samples. The following semi-volatile compounds were measured in about half of the samples: anthracene (0.044 - 0.2 ppm), benzo(a)anthracene (0.24 - 1 ppm), benzo(a)pyrene (0.31 - 1 ppm), benzo(b)fluoranthene (0.33 - 1.8 ppm), benzo(k)fluoranthene (0.34 - 2.1 ppm), chrysene (0.15 - 1.4 ppm), fluoranthene (0.32 - 3.6 ppm), phenanthrene (0.12 - 1.2 ppm) and pyrene (0.14 - 1.5 ppm). The following semi-volatile organic compounds were measured in less than half of the samples: benzo(g,h,i)perylene (0.25 - 0.95 ppm), dibenz(a,h)anthracene (0.13 - 0.2 ppm), fluorene (0.065 - 0.1 ppm) and indeno(1,2,3-cd)pyrene (0.24 - 0.83 ppm).

PCBs

Three Aroclors were detected in the Downstream Reach sediments: 1248, 1254 and 1260. Aroclors 1248 and 1254 were detected in about half the samples at concentrations ranging from 0.061 - 1.2 ppm and 0.034 to 1.4 ppm, respectively. Aroclor 1260 was only detected in one sample at 0.84 ppm. Total PCBs ranged from 0.101 to 3.44 ppm.

Pesticides and Herbicides

The following pesticides/herbicides were measured in less than one third of the samples at concentrations less than 0.03 ppm: aldrin, dieldrin, gamma-bhc, heptachlor and dinoseb.

Dioxins and Furans

Four sediment samples were analyzed for dioxins and furans from the Downstream Reach. OCDD was detected in three samples, ranging from 0.00054 to 0.0009 ppm. HPCDD was measured in one sample at 0.00014 ppm. Three forms of furans were detected once in the Downstream sediments: HPCDF at 0.0011 ppm, OCDF at 0.00037 ppm and TCDF at 0.0014 ppm.

Fingerprint Compounds

Tinuvin 327 was detected in two samples at 0.18 and 1.2 ppm. Tinuvin 328 was detected in six samples at concentrations ranging from 0.13 to 92 ppm.

Inorganics

The results of the organic analyses for the Downstream Reach surface sediment is presented in Table 4-18. Copper, zinc, arsenic and lead were detected in almost all sediments collected from the Downstream Reach. Copper concentrations ranged from 4 to 236 ppm, concentrations of zinc ranged from 31.3 to 511 ppm, arsenic concentrations ranged from 1.3 to 10.5 ppm and concentrations of lead ranged from 13.5 to 151 ppm. The following inorganics were measured in about half of the samples: barium (6.5 - 80.5 ppm), beryllium (0.49 - 1.7 ppm), calcium (340 - 3,800 ppm), chromium (5.6 - 44.5 ppm), cobalt (1.3 - 5.9 ppm), iron (5,760 - 11,600 ppm), magnesium (482 - 1,450 ppm) and manganese (79.9 - 353 ppm). The following metals were measured in less than half of the samples: cadmium (1.6 - 6.5 ppm), nickel (4.8 - 23.2 ppm), potassium (327 - 921 ppm), sodium (155 - 423 ppm), vanadium (4.1 - 10.2 ppm), selenium (0.442 - 0.578 ppm), thallium (0.442 - 0.578 ppm) and sulfide (36 - 120 ppm). Silver (1.6 ppm) and mercury (0.16 ppm) were measured in one sample each.

4.4.3 Discussion of Sediment Results

This section presents a discussion of the Pawtuxet River release characterization sediment results.

Volatile Organic Compounds

Chlorobenzene and toluene were detected in all four river reaches, though concentrations within the Upstream Reach and the Lower Facility Reach were all less than 1 ppm. The highest concentrations of chlorobenzene and toluene occurred in the Upper Facility Reach. Within the Upper Facility Reach, the highest concentrations of these volatile compounds were found in the deep sediment samples. In the Downstream Reach, only one sample exceeded 1 ppm for chlorobenzene and toluene: sediment sample 3A (chlorobenzene concentration 21 ppm and toluene concentration 6.1 ppm) was located about 1,000 feet downstream of the Warwick Avenue bridge, just before the southern meander bend in the river.

Semi-Volatile Organic Compounds

Bis(2-ethylhexyl)phthalate, the most commonly detected semi-volatile compound during the release characterization, was measured in all river reaches. Sediment concentrations of bis(2-ethylhexyl)phthalate were similar in the Upstream, Lower Facility and Downstream Reaches. The highest sediment concentrations were found in the Upper Facility Reach.

Naphthalene was detected in all reaches. Concentrations of naphthalene in upstream, lower facility and downstream sediments were all less than 1 ppm, except for downstream sample 3A (concentration 2.4 ppm), discussed in the previous section. The highest naphthalene concentrations occurred in the surface and shallow sediments of the Upper Facility Reach.

Because most of the PAH compounds were detected in all reaches at similar concentrations, these compounds were eliminated from study during Phase II, with the exception of naphthalene.

PCBs

No PCBs were detected in Upstream sediment samples. By far, the highest sediment PCB concentrations were measured in the sediments of the Upper Facility Reach. The samples collected from within the old cofferdam area, adjacent to the bulkhead, had the highest PCB concentrations. Within the Upper Facility Reach, the highest PCB concentrations were measured in the shallow (i.e., 1 to 2 foot) depth interval. Total PCB concentrations in sediments decrease moving downstream. Sediment PCB concentrations in the Lower Facility Reach were less than 12 ppm and in the Downstream Reach were less than 4 ppm. All Aroclors, except 1016, were detected in the sediments. The most commonly detected Aroclors were 1248 and 1254.

Pesticides and Herbicides

Although a variety of pesticides and herbicides were detected in all reaches, concentrations were all less than 1.0 ppm and generally less than 0.5 ppm. Based on the presence of these compounds upstream of the site and the low concentrations measured in the sediments, they were eliminated from further study during Phase II.

Dioxins and Furans

The primary forms of dioxin detected were HPCDD and OCDD. Concentrations of HPCDD and OCDD were higher in the shallow and deep sediments of the Upper Facility Reach than in the upstream samples.

The primary forms of furans detected were HPCDF, HXCDF and OCDF. No furans were detected in upstream sediments or surface sediments of the Upper Facility Reach. HPCDF, HXCDF and OCDF were detected in two samples from the Lower Facility Reach and one sample from the Downstream Reach. In addition, TCDF was detected in one sample from the Downstream Reach

Fingerprint Compounds

Tinuvin 327/328 was used as a fingerprint compound, in an attempt to correlate the presence of contamination with releases from the facility. No Tinuvin was detected in upstream samples, as expected. Tinuvin was detected in the lower facility and downstream sediments, but the highest concentrations were found in the surface sediments of the Upper Facility Reach.

Inorganics

Certain inorganic compounds are commonly found in sediments so these were excluded from Phase II analyses (i.e., barium, calcium, magnesium, manganese, iron, potassium, etc.). Copper, zinc, arsenic and lead were detected in all reaches and in almost all samples analyzed. Concentrations of these metals were highest in the Upper Facility Reach. Sediment metals concentrations in the Upstream, Lower Facility and Downstream Reaches were comparable. Within the Upper Facility Reach, the metals concentrations were highest in the surface sediments and decreased with depth, with the exception of arsenic. Sediment arsenic concentrations did not appear to attenuate with depth.

4.5 STATISTICAL ANALYSIS OF SEDIMENT CONTAMINATION

This section discusses the nature and extent of distribution of Phase II Analytes within the four river reaches: the Upstream, Upper Facility, Lower Facility and Downstream Reaches. Statistical comparisons of sediment concentrations of Phase II Analytes were made to evaluate differences in mean sediment concentrations between reaches. Within the Upper Facility Reach, sediment concentrations of Phase II Analytes within each depth interval were statistically compared to evaluate patterns of analyte distributions with depth.

4.5.1 Objectives Overview

One of the difficulties in evaluating sediment chemical composition is that certain constituents may occur naturally in sediment or may have been released into the river from an upstream source. The

Pawtuxet River flows through a highly industrialized area and receives wastewater from several POTWs and industries upstream of the CIBA-GEIGY facility. It is critical, therefore, to characterize the "naturally occurring" concentrations of constituents in sediment upstream of the Site to define "background" sediment concentrations of constituents.

The objectives of this section of the RFI are to:

- 1) Statistically compare concentrations of Phase II Analytes between reaches to define portions of the river where concentrations exceed background,
- 2) Statistically evaluate contaminant distributions with depth within the Upper Facility Reach to determine sediment concentrations of Phase II Analytes are statistically higher than background concentrations,
- 3) Evaluate the correlation of these areas to on-site activities.

4.5.2 Statistical Analysis Methods

A statistical analysis of the release characterization data was conducted to evaluate mean concentration differences for the Phase II Analytes among the four river reaches (i.e., Upstream, Upper Facility, Lower Facility and Downstream) and among the three depth intervals sampled within the Upper Facility Reach. To enable this comparison, a one-way analysis of variance (ANOVA) was performed on the data. Certain assumptions must be satisfied for proper application of the ANOVA test: samples must be independent, from normally distributed populations with similar variance. Environmental contaminant data rarely satisfy these assumptions. However, following log transformation of the release characterization data, the assumptions were satisfied and the ANOVA test could be applied.

In the analysis of variance, the observed variability is divided into two components:

- 1) the variability of the observations within a group about the group mean (or within cell variation), and

2) the variability of the group means (or between cell variation).

If the variability within the cells is small but the group means differ significantly, then there is evidence to suspect that the group means are statistically different. The ratio of the between cell variation to the within cell variation is the F ratio or F statistic. The calculated F statistic is compared to tables of the F distribution to estimate the significance level. The significance level is the probability of obtaining an F statistic at least as large as the one calculated when all population means are equal. If the significance level is small enough ($p < 0.05$ for 95% confidence), the null hypothesis (H_0) is rejected for the alternative hypothesis (H_a).

The two sets of hypotheses evaluated in this section are:

Among Reaches:

H_0 : The mean sediment concentrations are equal.

H_a : The mean sediment concentrations are not equal.

Among Upper Facility Reach depth intervals:

H_0 : The mean sediment concentrations within each depth interval are equal.

H_a : The mean sediment concentrations within each depth interval are not equal.

The results of the ANOVA will only indicate that mean sediment concentrations for a given constituent are not equal among reaches or depth intervals. To evaluate which reaches or depth intervals contained mean sediment concentrations that were statistically different, a multiple comparison test was conducted. The New Multiple Range Test was used to evaluate which reaches or depth intervals had mean sediment concentrations for a given constituent that were significantly different from one another. All tests for significance were evaluated at the 5% level of significance (i.e., 95% confidence). One-half the detection limits were used for non-detected values.

4.5.3 Results of Statistical Analysis of Sediment Data

Tables 4-19 and 4-20 summarize the results of the statistical analyses of the release characterization data. The results of these analyses are discussed in the following section.

Volatile Organic Constituents: The chlorobenzene and toluene concentrations of surface sediments in the Upper Facility Reach are significantly higher than those of the Upstream, Lower Facility and Downstream Reaches.

Within the Upper Facility Reach, there is no statistical difference in the sediment chlorobenzene concentration between depth intervals. The maximum concentration of chlorobenzene was measured in the deep sediments. Surface sediment concentrations of toluene were statistically significantly higher than subsurface sediment concentrations, although the maximum sediment concentrations of toluene occurred in the deepest sediments. Toluene was detected more frequently in surface sediments than in shallow or deep sediments of the Upper Facility Reach.

Semi-volatile Organic Constituents: Surface sediment naphthalene concentrations are significantly higher in the Upstream and Upper Facility Reach than in the Lower Facility or Downstream Reaches. There is no significant difference in surface sediment naphthalene concentrations in the Upstream and Upper Facility Reach. Surface sediment concentrations of bis(2-ethylhexyl)phthalate are significantly higher in the Upper Facility Reach than in all other reaches.

Within the Upper Facility Reach, the naphthalene and bis(2-ethylhexyl)phthalate concentrations in surface sediment are significantly higher than the subsurface sediment concentrations. However, the maximum bis(2-ethylhexyl)phthalate concentration measured in sediment was found in the deep sediment from the Upper Facility Reach.

PCBs: Surface sediment PCB concentrations in the Upper Facility Reach are significantly higher than all other reaches. The highest PCB concentrations were measured in sediment from the old cofferdam area. Within the Upper Facility Reach, there is no statistical difference in PCB

concentrations with depth. The highest sediment PCB concentration was measured in the shallow sediment of the Upper Facility Reach.

Pesticides and Herbicides:

The limited number of detected values for pesticides and herbicides prohibited application of statistical comparison of sediment concentrations. The pesticides and herbicides results were discussed previously.

Dioxins and Furans: The limited number of detected values of dioxin and furan prohibited application of statistical comparison of sediment concentrations. The dioxin and furan results were discussed previously.

Inorganics: The concentrations of copper, silver, zinc and arsenic in the surface sediment of the Upper Facility Reach are significantly higher than sediment concentrations of these metals in the Upstream, Lower Facility or Downstream Reaches. Sediment lead concentrations are significantly higher in the Upstream and Upper Facility Reach than in the Lower Facility or Downstream Reaches. No significant difference between sediment lead concentrations was observed between the Upstream and Upper Facility Reach.

Within the Upper Facility Reach, the surface sediment contained significantly higher concentrations of copper, silver, zinc, and lead than the subsurface sediments. Arsenic concentrations of surface sediments in the Upper Facility Reach were significantly higher than the shallow sediment (i.e., 1 to 2 foot depth), but not significantly different from the deeper sediments.

4.5.4 General Discussion of Statistical Analysis Results

Statistical analysis of the release characterization results shows that concentrations of copper, silver, zinc, arsenic, PCBs, chlorobenzene, toluene and bis(2-ethylhexyl)phthalate in surface sediment are significantly higher in the Upper Facility Reach than in the Upstream, Lower Facility and Downstream Reaches. Likewise, the surface sediment concentrations of copper, silver, zinc,

arsenic, PCBs, chlorobenzene, toluene and bis(2-ethylhexyl)phthalate are not significantly different in the Upstream, Lower Facility and Downstream Reaches.

The On-Site RFI results show that the shallow groundwater migrating from the Site to the river contained elevated concentrations of chlorobenzene, toluene, zinc and phthalates. This groundwater migration from the Site may have resulted in the significantly higher concentrations of these compounds within the Upper Facility Reach sediment.

PCBs were detected on-site in soils and groundwater. The sediment in the old cofferdam area had the highest PCB concentrations measured in river sediments.

The on-site data did not show elevated concentrations of copper, silver or arsenic. Yet, the statistical comparison showed concentrations of these metals to be statistically higher in the Upper Facility Reach surface sediment than in that of the other reaches. Metals are bound in sediment by organic carbon. The TOC content of the Upper Facility Reach sediment was higher than the sediment TOC in other reaches. To evaluate the effect of the high TOC concentrations in Upper Facility Reach surface sediments, the sediment concentrations of copper, silver and arsenic were normalized for TOC and the ANOVA test was rerun. No statistical difference was observed in the copper, silver or arsenic sediment concentrations between reaches, using the normalized data. In other words, the sediment of the Upper Facility Reach may be acting as a "sink" for these metals based on the high organic carbon content of these sediments. When the sediment data for zinc and PCBs were normalized by TOC concentration, the results did not change; the surface sediment of the Upper Facility Reach was still significantly higher than that of the remaining reaches. This suggests that zinc and PCBs have migrated from the Site to the river sediment in the Upper Facility Reach.

Surface sediment concentrations of lead and naphthalene in the Upstream and Upper Facility Reach are not significantly different. Based on the presence of lead and naphthalene upstream of the facility, in concentrations that are statistically comparable to those adjacent to the facility, the river sediments are not believed to have been impacted by the Site for these analytes.

Sediments downstream of the Production Area do not show any impact from the facility, based on comparison with sediments upstream of the facility.

Within the Upper Facility Reach, sediments were analyzed from three depth intervals to evaluate the vertical extent of contamination. The concentrations of all Phase II Analytes were higher in the surface sediments (i.e., 0-6 inches) than in the subsurface sediments with the exception of PCBs and chlorobenzene. The highest chlorobenzene concentrations were observed in the deep sediment of the Upper Facility Reach. This observation indicates that groundwater containing (elevated concentrations of VOCs) was entering the river in the Production Area. The presence of higher PCB concentrations in subsurface sediments may indicate historical releases from the Site that have been subsequently buried by deposition from upstream sources.

No statistical analyses was performed on the dioxin or furan data because these compounds were measured infrequently. Dioxins and furans were measured in on-site soils and groundwater. No dioxin or furan compounds were measured in the surface sediment of the Upper Facility Reach. Dioxin was measured in Upstream sediments, as well as, in the Lower Facility Reach and Downstream sediments. Dioxin was also measured in sediments greater than one foot deep in the Upper Facility Reach. No furans were measured in surface sediment Upstream of the facility or in the Upper Facility Reach. Furans were measured in the Lower Facility and Downstream sediment and in the subsurface sediment of the Upper Facility Reach.

4.6 RELEASE CHARACTERIZATION SUMMARY

The on-site releases that may have impacted the Pawtuxet River were discussed in Section 3.0. These releases included: migration of shallow groundwater from the Production Area, releases from Warwick Area and the Waste Water Treatment Area, and permitted discharges of process water to the former cofferdam. Each of these releases to the Pawtuxet River will be discussed in this section with regard to the results of the release characterization.

The results of the release characterization for river sediments confirm that groundwater migrating to the river in the Production Area has impacted river sediment quality. Historically, shallow groundwater from the Production Area (AOC-13 and SWMU-11) discharged to the river.

Concentrations of VOCs were higher in the sediment of the Upper Facility Reach than in all the other reaches. During Stabilization, however, a groundwater capture system (located along the bulkhead in the Production Area) and the soil vapor/groundwater extraction system (located at SWMU-11) were designed and constructed. The groundwater capture has been operating since September 1995. The groundwater capture system has reduced the hydraulic gradient along the bulkhead. As a consequence, discharge of shallow groundwater to the Pawtuxet River is minimized, thus reducing the potential impact to the river. The soil vapor extraction system is expected to start continuous operation in March 1996.

Accidental releases of wastewater from the Site were documented from SWMUs 10 and 12 in the Waste Water Treatment Area and from SWMU 9 in the Warwick Area (Figure 3-1). Wastewater migrating from these SWMUs entered the river in the Lower Facility Reach. Although the exact composition of the waste water was not known for all releases, in general, the waste water contained volatile and semi-volatile compounds, biodegradable organic compounds and zinc.

The results of the release characterization indicated no elevated concentrations of VOCs, semi-volatile organic compounds or zinc within the Lower Facility Reach sediment or water. There is no evidence of impact from these historical releases on surface water or sediment quality within the Lower Facility Reach. Likewise, surface water and sediments from the Downstream Reach did not have elevated concentrations of the compounds typically found in waste water from the facility, and therefore, show no evidence of impact from these on-site releases.

The sediment within the old cofferdam area had some of the highest concentrations of constituents measured during the release characterization. Surface water from this area was comparable in quality to the surface water from other reaches, indicating that the constituents present were bound in the sediments. These sediments were removed from the river during the implementation of the Cofferdam IRM in the Fall of 1995, thus, eliminating this potential source of contamination.

In summary, the primary source of contamination from the Site to the Pawtuxet River is AOC-13. A groundwater capture system is now operating to control releases from this area. There is

no evidence of impact to the river from historical releases of waste water (SWMUs 9, 10 and 12) from the facility.

Tables

TABLE 4-1
CRANSTON SITE
UPSTREAM REACH
RIVER SURFACE WATER
ORGANIC DATA

| SAMPLE ID COLLECTION DATE | SW-00M*IB-1 11/27/90 Result Q | SW-01R*IB-1 11/27/90 Result Q | SW-00M*IB-2 3/26/91 Result Q | SW-01M*IB-2 3/26/91 Result Q | UPSTREAM REACH SUMMARY | | | |
|-------------------------------------|-------------------------------------|-------------------------------------|------------------------------------|------------------------------------|------------------------------|---------------------|---|---------------------|
| | | | | | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Minimum Detected |
| VOLATILE ORGANICS | | | | | | | | |
| HALOGENATED | | | | | | | | |
| 8240W CHLOROBENZENE | 1 J | 1 J | 2.5 U | 2.5 U | 2 | 1.00 | 1.00 | 1 |
| 8240W CHLOROFORM | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 0 | | | |
| AROMATICS | | | | | | | | 0 |
| 8240W M&P-XYLENE | 2.5 U | 1.3 J | 2.5 U | 2.5 U | 1 | 1.30 | 1.30 | 1.3 |
| 8240W O-XYLENE | 2.5 U | 0.5 J | 2.5 U | 2.5 U | 1 | 0.50 | 0.50 | 0.5 |
| 8240W TOLUENE | 2.5 U | 1.3 J | 2.5 U | 2.5 U | 1 | 1.30 | 1.30 | 1.3 |
| KETONES/ALDEHYDES | | | | | | | | |
| 8240W IODOMETHANE | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 0 | | | |
| SEMI-VOLATILE ORGANICS | | | | | | | | 0 |
| PHTHALATES | | | | | | | | 0 |
| 8270W BIS(2-ETHYLHEXYL)PHTHALATE | 7 J | 7 J | 13.5 U | 4.75 U | 2 | 7.00 | 8.06 | 7 |
| 8270W DI-N-OCTYLPHTHALATE | 1.5 U | 1 U | 4.75 U | 4.75 U | 0 | | | |
| ORGANOCHLORINE PESTICIDES | | | | | | | | |
| 8080W 4,4'-DDE | 0.005 U | 0.00475 U | 0.00475 U | 0.00475 U | 0 | | | |
| 8080W 4,4'-DDT | 0.0105 U | 0.0095 U | 0.0095 U | 0.0095 U | 0 | | | |
| 8080W BETA-BHC | 0.005 U | 0.00475 U | 0.00475 U | 0.00475 U | 0 | | | |
| 8080W DIELDRIN | 0.005 U | 0.00475 U | 0.00475 U | 0.00475 U | 0 | | | |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | |
| 814ZW DIMETHOATE | 0.475 U | 0.475 U | 0.475 U | 0.475 U | 0 | | | |
| 814ZW DISULFOTON | 0.475 U | 0.475 U | 0.475 U | 0.475 U | 0 | | | |
| 814ZW ETHYL PARATHION | 0.355 U | 0.355 U | 0.355 U | 0.355 U | 0 | | | |
| 814ZW FAMPHUR | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 0 | | | |
| 814ZW METHYL PARATHION | 0.02 J | 0.07 U | 0.07 U | 0.07 U | 1 | 0.02 | 0.06 | 0.02 |

All results in ug/l (ppb).

U - non-detected (non-detected results are listed at one-half the reported detection limit).

R - Rejected.

J - Estimated.

F - Estimated maximum.

NA - Not analyzed.

TABLE 4-2
CRANSTON SITE
UPSTREAM REACH
RIVER SURFACE WATER
INORGANIC DATA

| LOCATION SAMPLE ID COLLECTION DATE TRANSECT | M SW-00M*IB-1[T] 11/27/90 0 | M SW-00M*IB-2[T] 3/26/91 0 | M SW-01M*IB-2[T] 3/26/91 1 | R SW-01R*IB-1[T] 11/27/90 1 | TOTAL | | | | |
|--|--------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|------------------------------|---------------------|---|---------------------|---------------------|
| | Result | Result | Result | Result | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| | Q | Q | Q | Q | | | | | |
| 6010W BARIUM | 16 | 14 | 14 | 15 | 4 | 14.8 | 14.8 | 16 | 14 |
| 6010W CALCIUM | 11600 | 6730 | 6610 | 11300 | 4 | 9060 | 9060 | 11600 | 6610 |
| 6010W CHROMIUM | 5 U | 5 U | 5 U | 5 U | 0 | | | | |
| 6010W IRON | 590 | 424 | 377 | 540 | 4 | 483 | 483 | 590 | 377 |
| 6010W MAGNESIUM | 1630 | 1220 | 1160 | 1570 | 4 | 1400 | 1400 | 1630 | 1160 |
| 6010W MANGANESE | 140 | 71 | 71 | 140 | 4 | 106 | 106 | 140 | 71 |
| 6010W NICKEL | 26 | 10 U | 10 U | 10 U | 1 | 26 | 14 | 26 | 26 |
| 6010W POTASSIUM | 1500 U | 1500 U | 1500 U | 1500 U | 0 | | | | |
| 6010W SILVER | 5 U | 5 U | 5 U | 5 U | 0 | | | | |
| 6010W SODIUM | 32600 | 17100 | 16800 | 31400 | 4 | 24500 | 24500 | 32600 | 16800 |
| 6010W ZINC | 25 | 10 U | 10 U | 10 U | 1 | 25 | 13.8 | 25 | 25 |
| 7421W LEAD | 23 | 3.5 J | 3.9 J | 4.9 | 4 | 8.83 | 8.83 | 23 | 3.5 |
| 9010W CYANIDE | 19 | 5 U | 5 U | 11 | 2 | 15 | 10 | 19 | 11 |

| LOCATION SAMPLE ID COLLECTION DATE TRANSECT | M SW-00M*IB-1[D] 11/27/90 0 | M SW-00M*IB-2[D] 3/26/91 0 | M SW-01M*IB-2[D] 3/26/91 1 | R SW-01R*IB-1[D] 11/27/90 1 | DISSOLVED | | | | |
|--|--------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|------------------------------|---------------------|---|---------------------|---------------------|
| | Result | Result | Result | Result | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| | Q | Q | Q | Q | | | | | |
| 6010W BARIUM | 14 | 12 | 13 | 14 | 4 | 13.3 | 13.3 | 14 | 12 |
| 6010W CALCIUM | 11700 | 6820 | 6580 | 11700 | 4 | 9200 | 9200 | 11700 | 6580 |
| 6010W CHROMIUM | 5 U | 5 U | 5 U | 5 U | 0 | | | | |
| 6010W IRON | 270 | 140 | 108 | 160 | 4 | 170 | 170 | 270 | 108 |
| 6010W MAGNESIUM | 1620 | 1160 | 1100 | 1620 | 4 | 1380 | 1380 | 1620 | 1100 |
| 6010W MANGANESE | 130 | 62 | 59 | 130 | 4 | 95.3 | 95.3 | 130 | 59 |
| 6010W NICKEL | 10 U | 10 U | 10 U | 20 | 1 | 20 | 12.5 | 20 | 20 |
| 6010W POTASSIUM | 3110 J | 1500 U | 1500 U | 1500 U | 1 | 3110 | 1900 | 3110 | 3110 |
| 6010W SILVER | 5 U | 5 U | 5 U | 5 U | 0 | | | | |
| 6010W SODIUM | 33200 | 17400 | 16900 | 32700 | 4 | 25100 | 25100 | 33200 | 16900 |
| 6010W ZINC | 10 U | 10 U | 10 U | 10 U | 0 | | | | |
| 7421W LEAD | 1.5 U | 1.5 U | 1.5 U | 5.1 | 1 | 5.1 | 2.4 | 5.1 | 5.1 |
| 9010W CYANIDE | NA | NA | NA | NA | 0 | | | | |

All results in ug/l (ppb).

U - non-detected (non-detected results are listed at one-half the reported detection limit).

R - Rejected.

J - Estimated.

F - Estimated maximum.

NA - Not analyze.

TABLE 4-3
CRANSTON SITE
FACILITY REACH
RIVER SURFACE WATER
ORGANIC DATA

| SAMPLE ID COLLECTION DATE | SW-03*IB-1R 11/27/90 Result Q | SW-04M*IB-2 3/26/91 Result Q | SW-06M*IB-1 11/27/90 Result Q | SW-07M*IB-1 11/27/90 Result Q | SW-08M*IB-1 11/27/90 Result Q | FACILITY REACH SUMMARY | | | | |
|-------------------------------------|-------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|------------------------------|---------------------|---|---------------------|---------------------|
| | | | | | | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| VOLATILE ORGANICS | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | |
| 8240W CHLOROBENZENE | 1.2 J | 2.5 U | 1.2 J | 1.1 J | 1 J | 4 | 1.13 | 1.40 | 1.2 | 1 |
| 8240W CHLOROFORM | 2.5 U | 4 J | 2.5 U | 2.5 U | 2.5 U | 1 | 4.00 | 2.80 | 4 | 4 |
| AROMATICS | | | | | | | | | | |
| 8240W M&P-XYLENE | 1.6 J | 2.5 U | 1.2 J | 2.5 U | 2.5 U | 2 | 1.40 | 2.06 | 1.6 | 1.2 |
| 8240W O-XYLENE | 0.5 J | 2.5 U | 0.5 J | 2.5 U | 2.5 U | 2 | 0.50 | 1.70 | 0.5 | 0.5 |
| 8240W TOLUENE | 1.3 J | 2 J | 1.1 J | 2.5 U | 2.5 U | 3 | 1.47 | 1.88 | 2 | 1.1 |
| KETONES/ALDEHYDES | | | | | | | | | | |
| 8240W IODOMETHANE | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 0 | | | | |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | |
| PHTHALATES | | | | | | | | | | |
| 8270W BIS(2-ETHYLHEXYL)PHTHALATE | 1 J | 4.75 U | 1 J | 3 J | 5 J | 4 | 2.50 | 2.95 | 5 | 1 |
| 8270W DI-N-OCTYLPHTHALATE | 4.8 U | 4.75 U | 4.8 U | 4.7 U | 4.75 U | 0 | | | | |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | |
| 8080W 4,4'-DDE | 0.0082 J | 0.00475 U | 0.00475 U | 0.00475 U | 0.00495 U | 1 | 0.01 | 0.01 | 0.0082 | 0.0082 |
| 8080W 4,4'-DDT | 0.0095 U | 0.0095 U | 0.0095 U | 0.0095 U | 0.025 | 1 | 0.03 | 0.01 | 0.025 | 0.025 |
| 8080W BETA-BHC | 0.00475 U | 0.00475 U | 0.00475 U | 0.048 | 0.038 | 2 | 0.04 | 0.02 | 0.048 | 0.038 |
| 8080W DIELDRIN | 0.00475 U | 0.00475 U | 0.0077 J | 0.00475 U | 0.00495 U | 1 | 0.01 | 0.01 | 0.0077 | 0.0077 |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | | |
| 8142W DIMETHOATE | R | 0.475 U | 0.475 U | 0.475 U | 0.475 U | 0 | | | | |
| 8142W DISULFOTON | R | 0.475 U | 0.022 J | 0.475 U | 0.475 U | 1 | 0.02 | 0.36 | 0.022 | 0.022 |
| 8142W ETHYL PARATHION | R | 0.355 U | 0.355 U | 0.355 U | 0.029 J | 1 | 0.03 | 0.27 | 0.029 | 0.029 |
| 8142W FAMPHUR | R | 1.2 U | 1.2 U | 0.073 J | 1.2 U | 1 | 0.07 | 0.92 | 0.073 | 0.073 |
| 8142W METHYL PARATHION | R | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0 | | | | |

All results in ug/l (ppb).

U - non-detected (non-detected results are listed at one-half the reported detection limit).

R - Rejected.

J - Estimated.

F - Estimated maximum.

NA - Not analyzed.

TABLE 4-4
CRANSTON SITE
FACILITY REACH
RIVER SURFACE WATER
INORGANIC DATA

| LOCATION SAMPLE ID COLLECTION DATE TRANSECT | R SW-03R*1B-1(T) 11/27/90 3 | M SW-04M*1B-2 (T) 3/26/91 4 | M SW-06M*1B-1(T) 11/27/90 6 | M SW-07M*1B-1(T) 11/27/90 7 | M SW-08M (T) 11/27/90 8 | TOTAL | | | | |
|--|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|------------------------------|---------------------|---|---------------------|---------------------|
| | Result Q | Result Q | Result Q | Result Q | Result Q | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| | | | | | | | | | | |
| 6010W BARIUM | 16 | 13 | 16 | 16 | 16 | 5 | 15.4 | 15.4 | 16 | 13 |
| 6010W CALCIUM | 11600 | 6710 | 11800 | 12000 | 12100 | 5 | 10800 | 10800 | 12100 | 6710 |
| 6010W CHROMIUM | 5 U | 5 U | 5 U | 5 U | 5 U | 0 | | | | |
| 6010W IRON | 550 | 368 | 550 | 1350 | 580 | 5 | 680 | 680 | 1350 | 368 |
| 6010W MAGNESIUM | 1620 | 1170 | 1660 | 1640 | 1670 | 5 | 1550 | 1550 | 1670 | 1170 |
| 6010W MANGANESE | 140 | 72 | 140 | 140 | 140 | 5 | 126 | 126 | 140 | 72 |
| 6010W NICKEL | 10 U | 10 U | 27 | 26 | 21 | 3 | 24.7 | 18.8 | 27 | 21 |
| 6010W POTASSIUM | 3200 J | 1500 U | 3180 | 3430 J | 3430 J | 4 | 3310 | 2950 | 3430 | 3180 |
| 6010W SILVER | 37 | 5 U | 5 U | 5 U | 5 U | 1 | 37 | 11.4 | 37 | 37 |
| 6010W SODIUM | 32200 | 17200 | 32600 | 32500 | 33000 | 5 | 29500 | 29500 | 33000 | 17200 |
| 6010W ZINC | 10 U | 10 U | 10 U | 10 U | 10 U | 0 | | | | |
| 7421W LEAD | 3.9 | 3.7 J | 1.8 U | 12 | 3.6 | 4 | 5.8 | 5 | 12 | 3.6 |
| 9010W CYANIDE | 10 | 5 U | 14 | 11 | 11 | 4 | 11.5 | 10.2 | 14 | 10 |

| LOCATION SAMPLE ID COLLECTION DATE TRANSECT | R SW-03R*1B-1(D) 11/27/90 3 | M SW-04M*1B-2 (D) 3/26/91 4 | M SW-06M*1B-1(D) 11/27/90 6 | M SW-07M*1B-1(D) 11/27/90 7 | M SW-08M (D) 11/27/90 8 | DISSOLVED | | | | |
|--|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|------------------------------|---------------------|---|---------------------|---------------------|
| | Result Q | Result Q | Result Q | Result Q | Result Q | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| | | | | | | | | | | |
| 6010W BARIUM | 13 | 12 | 54 | 14 | 59 | 5 | 30.4 | 30.4 | 59 | 12 |
| 6010W CALCIUM | 11700 | 6880 | 12000 | 12000 | 12200 | 5 | 11000 | 11000 | 12200 | 6880 |
| 6010W CHROMIUM | 5 U | 5 U | 5 U | 5 U | 5 U | 0 | | | | |
| 6010W IRON | 170 | 108 | 180 | 1110 | 190 | 5 | 352 | 352 | 1110 | 108 |
| 6010W MAGNESIUM | 1640 | 1160 | 1670 | 1660 | 1690 | 5 | 1560 | 1560 | 1690 | 1160 |
| 6010W MANGANESE | 130 | 63 | 130 | 140 | 130 | 5 | 119 | 119 | 140 | 63 |
| 6010W NICKEL | 20 | 10 U | 10 U | 21 | 32 | 3 | 24.3 | 18.6 | 32 | 20 |
| 6010W POTASSIUM | 3000 J | 1500 U | 3160 | 3430 J | 3260 J | 4 | 3210 | 2870 | 3430 | 3000 |
| 6010W SILVER | 5 U | 5 U | 5 U | 5 U | 5 U | 0 | | | | |
| 6010W SODIUM | 32700 | 17600 | 33700 | 32600 | 33600 | 5 | 30000 | 30000 | 33700 | 17600 |
| 6010W ZINC | 10 U | 10 U | 31 | 10 U | 40 | 2 | 35.5 | 20.2 | 40 | 31 |
| 7421W LEAD | 1.5 U | 1.5 U | 13 | 3.2 | 3.6 | 3 | 6.6 | 4.56 | 13 | 3.2 |
| 9010W CYANIDE | NA | NA | NA | NA | NA | 0 | | | | |

All results in ug/l (ppb).

U - non-detected (non-detected results are listed as one-half the reported detection limit).

R - Rejected.

J - Estimated.

F - Estimated maximum.

NA - Not analyze.

TABLE 4-5
CRANSTON SITE
DOWNSTREAM REACH
RIVER SURFACE WATER
ORGANIC DATA

| SAMPLE ID COLLECTION DATE | SW-09AL*IB-1 12/7/90 | SW-09M*IB-1 11/27/90 | SW-09M*IB-2 3/26/91 | SW-10M*IB-1 11/27/90 | SW-20M*IB-1 11/27/90 | SW-20M*IB-2 3/26/91 | DOWNSTREAM REACH SUMMARY | | | | |
|-------------------------------------|-------------------------|-------------------------|------------------------|-------------------------|-------------------------|------------------------|------------------------------|---------------------|---|---------------------|---------------------|
| | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| VOLATILE ORGANICS | | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | | |
| 8240W CHLOROBENZENE | 2.5 U | 1.1 J | 2.5 U | 1.1 J | 1.1 J | 2.5 U | 3 | 1.10 | 1.80 | 1.1 | 1.1 |
| 8240W CHLOROFORM | 2.5 U | 2.5 U | 2 J | 2.5 U | 2.5 U | 2.5 U | 1 | 2.00 | 2.42 | 2 | 2 |
| AROMATICS | | | | | | | | | | | |
| 8240W M&P-XYLENE | NA | 2.5 U | 2.5 U | 2.5 U | 1.6 J | 1 J | 2 | 1.30 | 2.02 | 1.6 | 1 |
| 8240W O-XYLENE | NA | 2.5 U | 2.5 U | 2.5 U | 0.7 J | 2.5 U | 1 | 0.70 | 2.14 | 0.7 | 0.7 |
| 8240W TOLUENE | 2.5 U | 2.5 U | 1 J | 2.5 U | 1.5 J | 2 J | 3 | 1.50 | 2.00 | 2 | 1 |
| KETONES/ALDEHYDES | | | | | | | | | | | |
| 8240W IODOMETHANE | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2 J | 1 | 2.00 | 2.42 | 2 | 2 |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | | |
| PHTHALATES | | | | | | | | | | | |
| 8270W BIS(2-ETHYLHEXYL)PHTHALATE | 13.5 U | 4 J | 4.75 U | 1 J | 1 J | 4.75 U | 3 | 2.00 | 4.83 | 4 | 1 |
| 8270W DI-N-OCTYLPHTHALATE | 10 | 4.75 U | 4.75 U | 5 U | 5 U | 4.75 U | 1 | 10.00 | 5.71 | 10 | 10 |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | | |
| 8080W 4,4'-DDE | 0.00495 U | 0.00475 U | 0.00475 U | 0.005 U | 0.0065 J | 0.00475 U | 1 | 0.01 | 0.01 | 0.0065 | 0.0065 |
| 8080W 4,4'-DDT | 0.01 U | 0.027 | 0.0095 U | 0.01 U | 0.01 U | 0.0095 U | 1 | 0.03 | 0.01 | 0.027 | 0.027 |
| 8080W BETA-BHC | 0.00495 U | 0.052 | 0.00475 U | 0.005 U | 0.005 U | 0.00475 U | 1 | 0.05 | 0.01 | 0.052 | 0.052 |
| 8080W DIELDRIN | 0.00495 U | 0.00475 U | 0.00475 U | 0.005 U | 0.005 U | 0.00475 U | 0 | | | | |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | | | |
| 8142W DIMETHOATE | 0.5 U | 0.475 U | 0.064 J | 0.475 U | 0.475 U | 0.475 U | 1 | 0.06 | 0.41 | 0.064 | 0.064 |
| 8142W DISULFOTON | 0.5 U | 0.475 U | 0.475 U | 0.475 U | 0.02 J | 0.475 U | 1 | 0.02 | 0.40 | 0.02 | 0.02 |
| 8142W ETHYL PARATHION | 0.385 U | 0.355 U | 0.355 U | 0.355 U | 0.355 U | 0.355 U | 0 | | | | |
| 8142W FAMPHUR | 1.3 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 0 | | | | |
| 8142W METHYL PARATHION | 0.075 U | 0.18 | 0.07 U | 0.07 U | 0.025 J | 0.07 U | 2 | 0.10 | 0.08 | 0.18 | 0.025 |

All results in ug/l (ppb).

U - non-detected (non-detected results are listed at one-half the reported detection limit).

R - Rejected.

J - Estimated.

F - Estimated maximum.

NA - Not analyzed.

TABLE 4-6
CRANSTON SITE
DOWNSTREAM REACH
RIVER SURFACE WATER
INORGANIC DATA

| LOCATION SAMPLE ID COLLECTION DATE TRANSECT | M SW-09M*1B-1(T) 11/27/90 9 | M SW-09M*1B-2 (T) 3/26/91 9 | M SW-10M*1B-1(T) 11/27/90 10 | M SW-20M*1B-1(T) 11/27/90 20 | M SW-20M*1B-2 (T) 3/26/91 20 | M SW-09AL*1B-1(T) 12/7/90 9 | TOTAL | | | | |
|--|--------------------------------------|--------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--------------------------------------|------------------------------|---------------------|---|---------------------|---------------------|
| | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| 6010W BARIUM | 16 | 14 | 16 | 16 | 14 | 14 | 6 | 15 | 15 | 16 | 14 |
| 6010W CALCIUM | 12400 | 6800 | 12600 | 12600 | 6860 | 7210 | 6 | 9750 | 9750 | 12600 | 6800 |
| 6010W CHROMIUM | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 0 | | | | |
| 6010W IRON | 620 | 385 | 2400 | 630 | 419 | 440 | 6 | 816 | 816 | 2400 | 385 |
| 6010W MAGNESIUM | 1690 | 1160 | 1700 | 1720 | 1170 | 1310 | 6 | 1460 | 1460 | 1720 | 1160 |
| 6010W MANGANESE | 140 | 72 | 150 | 140 | 76 | 88 | 6 | 111 | 111 | 150 | 72 |
| 6010W NICKEL | 10 U | 10 U | 27 | 26 | 10 U | 10 U | 2 | 26.5 | 15.5 | 27 | 26 |
| 6010W POTASSIUM | 3480 J | 1500 U | 3170 J | 3380 J | 1500 U | 1500 U | 3 | 3340 | 2420 | 3480 | 3170 |
| 6010W SILVER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 0 | | | | |
| 6010W SODIUM | 33100 | 17300 | 33000 | 33400 | 17400 | 18600 | 6 | 25500 | 25900 | 33400 | 17300 |
| 6010W ZINC | 10 U | 10 U | 31 | 10 U | 10 U | 10 U | 1 | 31 | 13.5 | 31 | 31 |
| 7421W LEAD | 8 | 3.4 J | 10 | 6.1 | 3.7 J | 2.15 U | 5 | 6.24 | 5.56 | 10 | 3.4 |
| 9010W CYANIDE | 12 | 5 U | 16 | 20 | 5 U | 5 U | 3 | 16 | 10.5 | 20 | 12 |

| LOCATION SAMPLE ID COLLECTION DATE TRANSECT | M SW-09M*1B-1(D) 11/27/90 9 | M SW-09M*1B-2 (D) 3/26/91 9 | M SW-10M*1B-1(D) 11/27/90 10 | M SW-20M*1B-1(D) 11/27/90 20 | M SW-20M*1B-2 (D) 3/26/91 20 | M SW-09AL*1B-1(D) 12/7/90 9 | DISSOLVED | | | | |
|--|--------------------------------------|--------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--------------------------------------|------------------------------|---------------------|---|---------------------|---------------------|
| | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| 6010W BARIUM | 74 | 12 | 68 | 50 | 12 | 11 | 6 | 37.8 | 37.8 | 74 | 11 |
| 6010W CALCIUM | 12400 | 6760 | 12500 | 12100 | 6840 | 6880 | 6 | 9580 | 9580 | 12500 | 6760 |
| 6010W CHROMIUM | 5 U | 5 U | 5 U | 22 | 5 U | 5 U | 1 | 22 | 7.83 | 22 | 22 |
| 6010W IRON | 290 | 127 | 370 | 350 | 116 | 87 | 6 | 223 | 223 | 370 | 87 |
| 6010W MAGNESIUM | 1660 | 1180 | 1700 | 1660 | 1160 | 1260 | 6 | 1440 | 1440 | 1700 | 1160 |
| 6010W MANGANESE | 130 | 61 | 130 | 130 | 63 | 67 | 6 | 96.8 | 96.8 | 130 | 61 |
| 6010W NICKEL | 27 | 10 U | 31 | 31 | 10 U | 10 U | 3 | 29.7 | 19.8 | 31 | 27 |
| 6010W POTASSIUM | 3290 J | 1500 U | 3560 J | 3260 J | 1500 U | 1500 U | 3 | 3370 | 2440 | 3560 | 3260 |
| 6010W SILVER | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 0 | | | | |
| 6010W SODIUM | 33400 | 17300 | 33600 | 32500 | 17400 | 17900 | 6 | 25400 | 25400 | 33600 | 17300 |
| 6010W ZINC | 49 | 10 U | 58 | 46 | 10 U | 10 U | 3 | 51 | 30.5 | 58 | 46 |
| 7421W LEAD | 6.7 | 1.5 U | 4.4 | 4.5 | 1.5 U | 1.5 U | 3 | 5.2 | 3.35 | 6.7 | 4.4 |
| 9010W CYANIDE | NA | NA | NA | NA | NA | NA | 0 | | | | |

All results in ug/l (ppb).

U - non-detected (non-detected results are listed at one-half the reported detection limit).

R - Rejected.

J - Estimated.

F - Estimated maximum.

NA - Not analyze.

TABLE 4-7
CRANSTON SITE
UPSTREAM REACH
RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TU | TU | TU | TU | TU | TU | TU | TU | TU | TU | TU | TU |
|--|--------------------------------|---------------------------------|---------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| | SD-00L*IB-2 | SD-00M*IB-1 | SD-01R*IB-1 | SD-01R*IB-2 | SD-DUP4*II-1 | SD-TU1A*II-1 | SD-TU2A*II-1 | SD-TU3A*II-1 | SD-TU4A*II-1 | SD-TU5A*II-1 | SD-TU6A*II-1 | SD-TU7A*II-1 |
| | 3/28/91 0 to .5 Result Q | 11/28/90 0 to .5 Result Q | 11/29/90 0 to .5 Result Q | 3/28/91 0 to .5 Result Q | 1/11/94 0 to .5 Result Q | 1/11/94 0 to .5 Result Q | 1/11/94 0 to .5 Result Q | 1/11/94 0 to .5 Result Q | 1/11/94 0 to .5 Result Q | 1/11/94 0 to .5 Result Q | 1/12/94 0 to .5 Result Q | 1/12/94 0 to .5 Result Q |
| VOLATILE ORGANICS | | | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | 0.155 U | 0.06 U | 0.07 U | 0.065 U | 0.0041 U | 0.003 U | 0.0115 U | 0.006 U | 0.0035 U | 0.011 U | 0.0036 U | 0.00385 U |
| 8240S CHLOROBENZENE | 0.155 U | 0.06 U | 0.64 | 0.065 U | 0.0041 U | 0.003 U | 0.0115 U | 0.006 U | 0.0035 U | 0.011 U | 0.0036 U | 0.00385 U |
| 8240S TRANS-1,2-DICHLOROETHENE | 0.155 U | 0.06 U | 0.07 U | 0.065 U | 0.0041 U | 0.003 U | 0.0115 U | 0.006 U | 0.0035 U | R | 0.0036 U | 0.00385 U |
| AROMATICS | | | | | | | | | | | | |
| 8240S BENZENE | 0.155 U | 0.06 U | 0.07 U | 0.065 U | 0.0041 U | 0.003 U | 0.0115 U | 0.006 U | 0.0035 U | 0.011 U | 0.0036 U | 0.00385 U |
| 8240S ETHYLBENZENE | 0.155 U | 0.06 U | 0.07 U | 0.065 U | 0.0041 U | 0.003 U | 0.0115 U | 0.006 U | 0.0035 U | 0.011 U | 0.0036 U | 0.00385 U |
| 8240S M&P-XYLENE | 0.155 U | 0.06 U | 0.021 J | 0.065 U | 0.0041 U | 0.007 J | 0.0115 U | 0.006 U | 0.0035 U | 0.011 U | 0.0036 U | 0.00385 U |
| 8240S NAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S O-XYLENE | 0.155 U | 0.06 U | 0.07 J | 0.065 U | 0.0041 U | 0.003 U | 0.0115 U | 0.006 U | 0.0035 U | 0.011 U | 0.0036 U | 0.00385 U |
| 8240S TOLUENE | 0.099 J | 0.06 U | 0.07 U | 0.065 U | 0.088 J | 0.003 U | 0.78 J | 0.034 J | 0.0063 J | 0.011 U | 0.0036 U | 0.00385 U |
| KETONES / ALDEHYDES | | | | | | | | | | | | |
| 8240S 2-BUTANONE | 0.58 J | 0.12 U | 0.145 U | 0.13 U | 0.0205 U | 0.015 U | 0.055 U | 0.03 U | 0.0175 U | 0.055 U | 0.018 U | 0.019 U |
| 8240S 2-HEXANONE | 0.25 J | 0.12 U | 0.145 U | 0.13 U | 0.0205 U | 0.015 U | 0.055 U | 0.03 U | 0.0175 U | 0.055 U | 0.018 U | 0.019 U |
| 8240S 4-METHYL-2-PENTANONE | 0.31 U | 0.12 U | 0.145 U | 0.13 U | 0.0205 U | 0.015 U | 0.055 U | 0.03 U | 0.0175 U | 0.055 U | 0.018 U | 0.019 U |
| 8240S ACETONE | 0.31 U | 0.12 U | 0.145 U | 0.13 U | 0.11 J | 0.015 U | 0.4 J | 0.03 U | 0.081 | 0.36 | 0.018 U | 0.019 U |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | | | |
| PAHs | | | | | | | | | | | | |
| 8270S ACENAPHTHENE | 1.5 U | 0.6 U | 0.2 J | 0.6 U | 0.27 U | 0.195 U | 0.376 U | 0.39 U | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| 8270S ACENAPHTHYLENE | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.063 J | 0.19 J | 0.24 U | 0.255 U |
| 8270S ANTHRACENE | 0.29 J | 0.11 J | 0.2 J | 0.14 J | 0.14 J | 0.022 J | 0.15 J | 0.13 J | 0.14 J | 0.53 J | 0.038 J | 0.05 J |
| 8270S BENZO(A)ANTHRACENE | 1.7 J | 0.28 J | 0.96 J | 0.51 J | 0.65 | 0.11 J | 0.68 J | 0.51 J | 0.53 | 2 | 0.11 J | 0.2 J |
| 8270S BENZO(A)PYRENE | 1.8 J | 0.6 U | 1.1 J | 0.43 J | 0.72 | 0.11 J | 0.72 J | 0.62 | 0.61 | 1.9 | 0.11 J | 0.22 J |
| 8270S BENZO(B)FLUORANTHENE | 3.3 | 0.41 J | 2.1 | 0.74 J | 1 | 0.16 J | 0.97 J | 0.85 | 0.85 | 2.9 | 0.16 J | 0.36 |
| 8270S BENZO(G,H,I)PERYLENE | 2 J | 0.6 U | 1.1 J | 0.39 J | 0.39 J | 0.195 U | 0.42 J | 0.39 J | 0.38 J | 1.2 | 0.24 U | 0.15 J |
| 8270S BENZO(K)FLUORANTHENE | 3.7 | 0.42 J | 2.2 | 0.83 J | 0.38 | 0.135 U | 0.38 J | 0.29 J | 0.32 | 1.2 | 0.165 U | 0.14 J |
| 8270S CHRYSENE | 2.4 J | 0.34 J | 1.4 | 0.61 J | 0.87 | 0.13 J | 0.88 J | 0.78 J | 0.84 | 2.8 | 0.14 J | 0.27 J |
| 8270S DIBENZO(A,H)ANTHRACENE | 0.7 J | 0.6 U | 0.7 U | 0.19 J | 0.12 J | 0.12 U | 0.225 U | 0.24 U | 0.11 J | 0.34 J | 0.145 U | 0.155 U |
| 8270S FLUORANTHENE | 8 | 0.64 J | 2.3 | 1.7 | 1.5 | 0.22 J | 1.5 J | 1.3 | 1.4 | 3.7 | 0.37 J | 0.58 |
| 8270S FLUORENE | 0.15 J | 0.069 J | 0.18 J | 0.084 J | 0.27 U | 0.195 U | 0.376 U | 0.39 U | 0.11 J | 0.7 U | 0.24 U | 0.255 U |
| 8270S INDENO(1,2,3-CD)PYRENE | 1.6 J | 0.6 U | 1.2 J | 0.32 J | 0.44 | 0.12 U | 0.42 J | 0.4 J | 0.38 | 1.3 | 0.145 U | 0.15 J |
| 8270S 2-METHYLNAPHTHALENE | 1.5 U | 0.6 U | 9.9 | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.435 U | 0.24 U | 0.255 U |
| 8270S NAPHTHALENE | 0.093 J | 0.6 U | 0.7 U | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.435 U | 0.24 U | 0.255 U |
| 8270S PHENANTHRENE | 1.8 J | 0.74 J | 1.3 J | 0.65 J | 0.78 | 0.12 J | 0.84 J | 0.51 J | 0.94 | 1.4 J | 0.18 J | 0.23 J |
| 8270S PYRENE | 1.9 J | 0.76 J | 2.3 | 0.61 J | 1.3 | 0.26 J | 1.6 | 1.2 | 1.4 | 3.6 | 0.26 J | 0.56 |
| PHTHALATES | | | | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 1.5 U | 0.6 U | 2.5 | 0.6 U | 1.8 J | 1.5 | 10 J | 2.2 | 6.5 | 0.55 J | 0.58 | 2.4 |
| 8270S BUTYLBENZYL PHTHALATE | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.27 U | 0.18 J | 0.24 J | 0.18 J | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| 8270S DI-N-BUTYL PHTHALATE | 1.5 U | 0.6 U | 0.7 U | 0.033 J | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| 8270S DI-N-OCTYL PHTHALATE | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.11 J | 0.17 J | 0.82 J | 0.39 U | 0.29 J | 0.7 U | 0.24 U | 0.255 U |
| 8270S DIMETHYL PHTHALATE | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| HALOGENATED | | | | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| 8270S 1,2-DICHLOROBENZENE | 1.5 U | 0.6 U | 0.12 J | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| 8270S 1,3-DICHLOROBENZENE | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| 8270S 1,4-DICHLOROBENZENE | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| 8270S 4-CHLOROANILINE | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.55 U | 0.39 U | 0.75 U | 0.8 U | 0.465 U | 1.45 U | 0.48 U | 0.33 J |
| PHENOLS | | | | | | | | | | | | |
| 8270S 2-METHYLPHENOL | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.7 U | 0.26 J | 0.255 U |
| 8270S 4-METHYLPHENOL | 1.2 J | 0.6 U | 0.7 U | 0.6 U | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PENTACHLOROPHENOL | 7.5 U | 3 U | 3.6 U | 3.1 U | 1.4 U | 1 U | 1.95 U | 2 U | 1.2 U | 3.7 U | 1.25 U | 1.3 U |
| 8270S PHENOL | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| OTHER | | | | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | 1.5 U | 0.6 U | 0.7 U | 0.6 U | 0.27 U | 0.195 U | 0.375 U | 0.39 U | 0.23 U | 0.7 U | 0.24 U | 0.255 U |
| FINGERPRINT COMPOUNDS | | | | | | | | | | | | |
| 8270S TINUVIN 327 | 7.5 U | 3 U | 3.6 U | 3.1 U | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TINUVIN 328 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PCBs | | | | | | | | | | | | |
| 8080S PCB-1221 | 0.031 U | 0.0115 U | 0.285 U | 0.0125 U | 0.055 U | 0.04 U | 0.075 U | 0.08 U | 0.047 U | 0.75 U | 0.0485 U | 0.05 U |
| 8080S PCB-1232 | 0.031 U | 0.0115 U | 0.285 U | 0.0125 U | 0.027 U | 0.0195 U | 0.0375 U | 0.039 U | 0.023 U | 0.36 U | 0.024 U | 0.0255 U |
| 8080S PCB-1242 | 0.0155 U | 0.0055 U | 0.145 U | 0.0065 U | 0.027 U | 0.0195 U | 0.0375 U | 0.039 U | 0.023 U | 0.36 U | 0.024 U | 0.0255 U |
| 8080S PCB-1248 | 0.0155 U | 0.0055 U | 0.145 U | 0.0065 U | 0.027 U | 0.0195 U | 0.0375 U | 0.039 U | 0.023 U | 0.36 U | 0.024 U | 0.0255 U |
| 8080S PCB-1254 | 0.031 U | 0.0115 U | 0.285 U | 0.0125 U | 0.027 U | 0.0195 U | 0.0375 U | 0.039 U | 0.023 U | 0.36 U | 0.024 U | 0.0255 U |
| 8080S PCB-1260 | 0.031 U | 0.0115 U | 0.285 U | 0.0125 U | 0.027 U | 0.0195 U | 0.0375 U | 0.039 U | 0.023 U | 0.36 U | 0.024 U | 0.0255 U |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | | | |
| 8080S 4,4'-DDD | 0.028 | 0.00055 U | 0.0145 U | 0.00065 U | 0.0075 J | 0.0014 J | 0.0077 J | 0.0071 J | 0.014 J | 0.036 U | 0.0029 J | 0.00255 U |
| 8080S 4,4'-DDE | 0.00155 U | 0.00055 U | 0.0145 U | 0.00065 U | 0.0023 J | 0.00195 U | 0.0082 J | 0.013 J | 0.029 J | 0.036 U | 0.0028 J | 0.00092 J |
| 8080S 4,4'-DDT | 0.007 | 0.00115 U | 0.0285 U | 0.00125 U | 0.0027 U | 0.00195 U | 0.0069 J | 0.0033 J | 0.0021 J | 0.036 U | 0.0012 J | 0.0019 J |
| 8080S ALDRIN | 0.049 | 0.00055 U | 0.0145 U | 0.00018 | 0.0014 U | 0.001 U | 0.0015 J | 0.002 J | 0.0012 U | 0.0185 U | 0.00125 U | 0.0013 U |
| 8080S ALPHA-BHC | 0.00155 U | 0.00055 U | 0.0145 U | 0.00065 U | 0.0014 U | 0.001 U | 0.00195 U | 0.002 U | 0.0012 U | 0.0185 U | 0.00125 U | 0.0013 U |
| 8080S ALPHA-CHLORDANE | 0.018 | 0.00055 U | 0.0145 U | 0.00065 U | 0.0035 J | 0.001 U | 0.011 J | 0.0078 J | 0.0065 J | 0.0185 U | 0.0008 J | 0.0013 U |
| 8080S BETA-BHC | 0.00155 U | 0.00055 U | 0.0145 U | 0.00065 U | 0.00052 J | 0.001 U | 0.0031 J | 0.0013 J | 0.0012 U | 0.0185 U | 0.0013 J | 0.0013 U |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | 0.014 U | 0.0071 J | 0.077 J | 0.064 J | 0.012 U | 0.185 U | 0.0125 U | 0.015 J |

TABLE 4-7
CRANSTON SITE
UPSTREAM REACH
RIVER SEDIMENT
ORGANIC DATA

| REACH | | TU | | UPSTREAM SUMMARY | | | |
|--------------------------------|----------------------------|-----------|------------------------|------------------|---|------------------|------------------|
| SAMPLE ID | SD-TU8A*11-1 | | | | | | |
| COLLECT DATE | 1/12/94 | | | | | | |
| DEPTH RANGE (FT) | 0 to 5 | | | | | | |
| | Result | Q | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| VOLATILE ORGANICS | | | | | | | |
| HALOGENATED | | | | | | | |
| 8240S | 1,1,2,2-TETRACHLOROETHANE | 0.0046 | U | 0 | | | |
| 8240S | CHLOROBENZENE | 0.0046 | U | 1 | 0.64 | 0.64 | 0.64 |
| 8240S | TRANS-1,2-DICHLOROETHENE | 0.0046 | U | 0 | | | |
| AROMATICS | | | | | | | |
| 8240S | BENZENE | 0.0046 | U | 0 | | | |
| 8240S | ETHYLBENZENE | 0.0046 | U | 0 | | | |
| 8240S | M&P-XYLENE | 0.0046 | U | 2 | 0.014 | 0.0274 | 0.021 |
| 8240S | NAPHTHALENE | NA | | 0 | | | 0.007 |
| 8240S | O-XYLENE | 0.0046 | U | 1 | 0.07 | 0.0309 | 0.07 |
| 8240S | TOLUENE | 0.0046 | U | 5 | 0.201 | 0.0943 | 0.78 |
| KETONES / ALDEHYDES | | | | | | | |
| 8240S | 2-BUTANONE | 0.023 | U | 1 | 0.58 | 0.0945 | 0.58 |
| 8240S | 2-HEXANONE | 0.023 | U | 1 | 0.25 | 0.0691 | 0.25 |
| 8240S | 4-METHYL-2-PENTANONE | 0.023 | U | 0 | | | |
| 8240S | ACETONE | 0.023 | U | 4 | 0.238 | 0.135 | 0.4 |
| SEMI-VOLATILE ORGANICS | | | | | | | |
| PAHs | | | | | | | |
| 8270S | ACENAPHTHENE | 0.305 | U | 1 | 0.2 | 0.451 | 0.2 |
| 8270S | ACENAPHTHYLENE | 0.305 | U | 2 | 0.127 | 0.437 | 0.19 |
| 8270S | ANTHRACENE | 0.061 | J | 13 | 0.153 | 0.153 | 0.53 |
| 8270S | BENZO(A)ANTHRACENE | 0.21 | J | 13 | 0.65 | 0.65 | 2 |
| 8270S | BENZO(A)PYRENE | 0.24 | J | 12 | 0.715 | 0.706 | 1.9 |
| 8270S | BENZO(B)FLUORANTHENE | 0.42 | | 13 | 1.1 | 1.1 | 3.3 |
| 8270S | BENZO(G,H,I)PERYLENE | 0.18 | J | 10 | 0.66 | 0.587 | 2 |
| 8270S | BENZO(K)FLUORANTHENE | 0.14 | J | 11 | 0.909 | 0.792 | 3.7 |
| 8270S | CHRYSENE | 0.31 | J | 13 | 0.906 | 0.906 | 2.8 |
| 8270S | DIBENZO(A,H)ANTHRACENE | 0.185 | U | 5 | 0.292 | 0.295 | 0.7 |
| 8270S | FLUORANTHENE | 0.62 | | 13 | 1.68 | 1.68 | 6 |
| 8270S | FLUORENE | 0.305 | U | 5 | 0.115 | 0.254 | 0.18 |
| 8270S | INDENO(1,2,3-CD)PYRENE | 0.18 | J | 10 | 0.639 | 0.558 | 1.6 |
| 8270S | 2-METHYLNAPHTHALENE | 0.305 | U | 1 | 9.9 | 1.18 | 9.9 |
| 8270S | NAPHTHALENE | 0.305 | U | 1 | 0.093 | 0.361 | 0.093 |
| 8270S | PHENANTHRENE | 0.3 | J | 13 | 0.738 | 0.738 | 1.6 |
| 8270S | PYRENE | 0.53 | J | 13 | 1.25 | 1.25 | 3.6 |
| PHTHALATES | | | | | | | |
| 8270S | BIS(2-ETHYLHEXYL)PHTHALATE | 2.2 | | 10 | 3.02 | 2.53 | 10 |
| 8270S | BUTYLBENZYLPHTHALATE | 0.305 | U | 3 | 0.2 | 0.462 | 0.24 |
| 8270S | DI-N-BUTYLPHTHALATE | 0.305 | U | 1 | 0.033 | 0.446 | 0.033 |
| 8270S | DI-N-OCTYLPHTHALATE | 0.38 | J | 5 | 0.37 | 0.526 | 0.92 |
| 8270S | DIMETHYLPHTHALATE | 0.305 | U | 0 | | | 0.11 |
| HALOGENATED | | | | | | | |
| 8270S | 1,2,4-TRICHLOROBENZENE | 0.305 | U | 0 | | | |
| 8270S | 1,2-DICHLOROBENZENE | 0.305 | U | 1 | 0.12 | 0.445 | 0.12 |
| 8270S | 1,3-DICHLOROBENZENE | 0.305 | U | 0 | | | |
| 8270S | 1,4-DICHLOROBENZENE | 0.305 | U | 0 | | | |
| 8270S | 4-CHLOROANILINE | 0.8 | U | 1 | 0.33 | 0.709 | 0.33 |
| PHENOLS | | | | | | | |
| 8270S | 2-METHYLPHENOL | 0.305 | U | 0 | | | |
| 8270S | 3&4-METHYLPHENOL | 0.305 | U | 1 | 0.26 | 0.331 | 0.26 |
| 8270S | 4-METHYLPHENOL | NA | | 1 | 1.2 | 0.775 | 1.2 |
| 8270S | PENTACHLOROPHENOL | 1.55 | U | 0 | | | |
| 8270S | PHENOL | 0.305 | U | 0 | | | |
| OTHER | | | | | | | |
| 8270S | 5-NITRO-O-TOLUIDINE | 0.12 | J | 1 | 0.12 | 0.475 | 0.12 |
| FINGERPRINT COMPOUNDS | | | | | | | |
| 8270S | TINUVIN 327 | NA | | 0 | | | |
| 8270S | TINUVIN 328 | NA | | 0 | | | |
| PCBs | | | | | | | |
| 8080S | PCB-1221 | | R | 0 | | | |
| 8080S | PCB-1232 | | R | 0 | | | |
| 8080S | PCB-1242 | | R | 0 | | | |
| 8080S | PCB-1248 | | R | 0 | | | |
| 8080S | PCB-1254 | | R | 0 | | | |
| 8080S | PCB-1260 | | R | 0 | | | |
| ORGANOCHLORINE PESTICIDES | | | | | | | |
| 8080S | 4,4'-DDD | 0.016 | J | 8 | 0.0106 | 0.0107 | 0.028 |
| 8080S | 4,4'-DDE | 0.045 | J | 7 | 0.0145 | 0.012 | 0.045 |
| 8080S | 4,4'-DDT | 0.0034 | J | 7 | 0.00354 | 0.00741 | 0.007 |
| 8080S | ALDRIN | | R | 3 | 0.0174 | 0.00783 | 0.049 |
| 8080S | ALPHA-BHC | | R | 0 | | | 0.0015 |
| 8080S | ALPHA-CHLORDANE | 0.002 | J | 7 | 0.00706 | 0.00661 | 0.018 |
| 8080S | BETA-BHC | | R | 4 | 0.00156 | 0.00379 | 0.0031 |
| 8080S | CHLOROBENZILATE | | R | 4 | 0.0408 | 0.0483 | 0.077 |
| 8080S | DIELDRIN | | R | 5 | 0.00517 | 0.007 | 0.0081 |
| 8080S | ENDOSULFAN I | | R | 3 | 0.00767 | 0.00531 | 0.01 |
| 8080S | ENDOSULFAN II | | R | 3 | 0.00383 | 0.0091 | 0.0058 |
| 8080S | ENDOSULFAN SULFATE | 0.0068 | J | 4 | 0.00388 | 0.0112 | 0.0066 |
| 8080S | ENDRIN | | R | 4 | 0.00116 | 0.00541 | 0.0022 |
| 8080S | ENDRIN ALDEHYDE | | R | 3 | 0.0042 | 0.00803 | 0.0047 |
| 8080S | GAMMA-BHC | | R | 2 | 0.0166 | 0.0064 | 0.029 |
| 8080S | GAMMA-CHLORDANE | | R | 9 | 0.00787 | 0.0087 | 0.023 |
| 8080S | HEPTACHLOR | | R | 1 | 0.013 | 0.00478 | 0.013 |
| 8080S | HEPTACHLOR EPOXIDE | | R | 3 | 0.00153 | 0.00378 | 0.0016 |
| 8080S | KEPONE | | R | 2 | 0.0135 | 0.0249 | 0.014 |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | |
| 8142S | DISULFOTON | 0.12 | U | 0 | | | |
| 8142S | METHYL PARATHION | 0.0155 | U | 0 | | | |
| HERBICIDES | | | | | | | |
| 8152S | 2,4-D | 0.0155 | U | 0 | | | |
| 8152S | DINOSEB | NA | | 0 | | | |
| CHLORINATED DIOXINS AND FURANS | | | | | | | |
| 8270S | DCDF | NA | | 0 | | | |
| 8270S | DIBENZOFURAN | 0.305 | U | 1 | 0.12 | 0.445 | 0.12 |
| 8270S | TRCDF | NA | | 1 | 0.43 | 1.47 | 0.43 |
| SOWZS | 1,2,3,4,6,7,8-HPCDD | 0.00018 | J | 1 | 0.00018 | 0.0000873 | 0.00018 |
| SOWZS | 1,2,3,4,6,7,8-HPCDF | 0.000116 | U | 0 | | | |
| SOWZS | 1,2,3,4,7,8,9-HPCDF | 0.00014 | U | 0 | | | |
| SOWZS | 1,2,3,4,7,8-HXCDF | 0.0000365 | U | 0 | | | |
| SOWZS | 1,2,3,6,7,8-HXCDF | 0.000032 | U | 0 | | | |
| SOWZS | 2,3,7,8-TCDF | 0.000075 | U | 0 | | | |
| SOWZS | HPCDD | 0.00038 | J | 1 | 0.00036 | 0.000107 | 0.00036 |
| SOWZS | HPCDF | 0.000116 | U | 0 | | | |
| SOWZS | HXCDF | 0.000032 | U | 0 | | | |
| SOWZS | OCDD | 0.0017 | J | 7 | 0.000667 | 0.000537 | 0.0017 |
| SOWZS | OCDF | 0.000335 | U | 0 | | | |
| SOWZS | TCDF | 0.000075 | U | 0 | | | |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-8
CRANSTON SITE
UPSTREAM REACH
RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TU SD-00L*IB-2 3/28/91 0 to .5 Result Q | TU SD-00M*IB-1 11/28/90 0 to .5 Result Q | TU SD-01R*IB-1 11/29/90 0 to .5 Result Q | TU SD-01R*IB-2 3/28/91 0 to .5 Result Q | TU SD-DUP4*II-1 1/11/94 0 to .5 Result Q | TU SD-TU1A*II-1 1/11/94 0 to .5 Result Q | TU SD-TU2A*II-1 1/11/94 0 to .5 Result Q | TU SD-TU3A*II-1 1/11/94 0 to .5 Result Q | TU SD-TU4A*II-1 1/11/94 0 to .5 Result Q | TU SD-TU5A*II-1 1/11/94 0 to .5 Result Q | TU SD-TU6A*II-1 1/12/94 0 to .5 Result Q | TU SD-TU7A*II-1 1/12/94 0 to .5 Result Q | TU SD-TU8A*II-1 1/12/94 0 to .5 Result Q | UPSTREAM REACH SUMMARY | | | | |
|---|---|--|--|---|--|--|--|--|--|--|--|--|--|------------------------------|---------------------|---|---------------------|---------------------|
| | | | | | | | | | | | | | | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| 6010S ANTIMONY | NA | NA | NA | NA | 4.1 U | 3 U | 5.65 U | 6 U | 3.55 U | 10.95 U | 3.65 U | 3.85 U | 4.6 U | 0 | | | | |
| 7041S ANTIMONY | 0.75 U | 0.33 U | 0.96 J | 0.23 U | NA | NA | NA | NA | NA | NA | NA | NA | NA | 1 | 0.96 | 0.568 | 0.96 | 0.96 |
| 6010S BARIUM | 97.6 J | 13.1 J | 31.5 J | 14.4 J | 35.7 | 9.9 | 52.6 | 89 | 25 | 83.8 | 23 | 33 | 55.9 | 13 | 43.4 | 43.4 | 97.6 | 9.9 |
| 6010S BERYLLIUM | 2.1 J | 0.5 | 0.59 | 0.42 J | 0.41 U | 0.3 U | 0.55 U | 2.1 | 0.355 U | 2.2 | 0.365 U | 0.385 U | 1.2 | 7 | 1.3 | 0.883 | 2.2 | 0.42 |
| 6010S CADMIUM | 7.4 J | 0.25 U | 2.4 | 0.235 U | 2.5 | 0.3 U | 4 | 3.5 | 1.4 | 2.7 | 0.8 | 1.2 | 3.1 | 10 | 2.9 | 2.29 | 7.4 | 0.8 |
| 6010S CALCIUM | 2490 J | 883 J | 965 J | 497 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 1210 | 1210 | 2490 | 497 |
| 6010S CHROMIUM | 43.5 J | 16.4 J | 49.6 J | 10.8 J | 23.3 | 9.6 | 32.9 | 89.7 | 30.7 | 2190 | 25.1 | 21 | 62.7 | 13 | 200 | 200 | 2190 | 9.6 |
| 6010S COBALT | 8.3 | 2.1 J | 3.3 J | 2.3 | 2.9 | 1.4 | 6 | 6.9 | 2.3 | 7.5 | 3 | 2.7 | 4.9 | 13 | 4.12 | 4.12 | 8.3 | 1.4 |
| 6010S COPPER | 97.6 J | 9 J | 68.4 J | 27.3 J | 45.8 J | 10.9 J | 109 J | 72.6 J | 39.5 J | 164 J | 27.4 J | 50.5 J | 71.8 J | 13 | 61.1 | 61.1 | 164 | 9 |
| 6010S IRON | 15800 | 7230 | 7700 | 4770 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 8880 | 8880 | 15800 | 4770 |
| 6010S MAGNESIUM | 2180 | 1570 J | 974 J | 908 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 1410 | 1410 | 2180 | 908 |
| 6010S MANGANESE | 344 | 137 J | 147 J | 88.3 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 179 | 179 | 344 | 88.3 |
| 6010S NICKEL | 30.3 J | 2.9 U | 13.1 | 4.8 J | 11.1 | 2.4 U | 16.9 | 30.1 | 11.2 | 8.75 U | 2.9 U | 9.3 | 11.5 | 9 | 15.4 | 11.9 | 30.3 | 4.8 |
| 6010S POTASSIUM | 1440 | 472 | 390 | 300 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 651 | 651 | 1440 | 300 |
| 6010S SILVER | 1.35 U | 0.495 U | 0.55 U | 0.475 U | 0.8 U | 0.6 U | 1.15 U | 1.2 U | 0.7 U | 2.2 U | 0.75 U | 0.75 U | 0.9 U | 0 | | 0.917 | | |
| 6010S SODIUM | 446 | 82.5 U | 104.5 U | 145 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 2 | 296 | 195 | 446 | 145 |
| 6010S TIN | NA | NA | NA | NA | 4.1 U | 3 U | 5.65 U | 14.1 | 3.55 U | 113 | 8.9 | 3.85 U | 4.6 U | 3 | 45.3 | 17.9 | 113 | 8.9 |
| SNZZS TIN | 13.5 U | 4.95 U | 5.5 U | 4.75 U | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S VANADIUM | 14.5 | 4.4 | 11.1 | 3.1 | 5.2 | 2.2 | 8 | 14.9 | 3.8 | 7.6 | 4.9 | 5.7 | 7.9 | 13 | 7.18 | 7.18 | 14.9 | 2.2 |
| 6010S ZINC | 229 J | 35.2 J | 135 J | 28 J | 90 | 22.3 | 126 | 148 | 90.7 | 452 | 55.8 | 63.1 | 127 | 13 | 123 | 123 | 452 | 22.3 |
| 7060S ARSENIC | 18.5 | 9.8 J | 6.2 J | 5.2 | 2.9 | 0.6 U | 1.15 U | 14.2 | 1.6 | 29.5 | 10.7 | 5.9 | 2.2 | 11 | 9.7 | 8.34 | 29.5 | 1.6 |
| 7421S LEAD | 131 J | 19.7 | 173 | 11 J | 43.5 | 11.1 | 46 | 134 | 30 | 745 | 73 | 50.5 | 67.8 | 13 | 118 | 118 | 745 | 11 |
| 7472S MERCURY | 0.07 U | 0.025 U | 0.14 J | 0.028 U | 0.08 | 0.06 | 0.12 | 0.17 | 0.09 | 5.6 | 0.17 | 0.05 | 0.12 | 10 | 0.66 | 0.517 | 5.6 | 0.05 |
| 7740S SELENIUM | 1.08 | 0.235 U | 0.3 U | 0.325 | 0.8 U | 0.6 U | 1.15 U | 1.2 U | 0.7 U | 2.2 U | 0.75 U | 0.75 U | 0.9 U | 2 | 0.703 | 0.845 | 1.08 | 0.325 |
| 7841S THALLIUM | 1.08 | 0.235 U | 0.3 U | 0.325 | 0.8 U | 0.6 U | 1.15 U | 1.2 U | 0.7 U | 2.2 U | 0.75 U | 0.75 U | 0.9 U | 2 | 0.703 | 0.845 | 1.08 | 0.325 |
| 9010S CYANIDE | 0.38 U | 0.29 U | 0.305 U | 0.175 U | R | R | R | R | 20.5 J | 8.5 J | R | R | 9.3 J | 3 | 12.8 | 5.64 | 20.5 | 8.5 |
| 9030S SULFIDE | 1600 | 12 U | 57 | 180 | 233 J | R | 89.5 J | 60.8 J | 222 J | 53.7 J | R | R | 145 J | 9 | 293 | 265 | 1600 | 53.7 |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-9
CRANSTON SITE
UPPER FACILITY REACH
SURFACE RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TUF SD-02L*IB-1 11/28/90 0 to .5 Result Q | TUF SD-02L*IB-2 3/26/91 0 to .5 Result Q | TUF SD-02R*IB-1 11/28/90 0 to .5 Result Q | TUF SD-02R*IB-2 3/26/91 0 to .5 Result Q | TUF SD-03L*IB-1 11/28/90 0 to .5 Result Q | TUF SD-03L*IB-2 3/27/91 0 to .5 Result Q | TUF SD-03R*IB-1 11/28/90 0 to .5 Result Q | TUF SD-03R*IB-2 3/28/91 0 to .5 Result Q | TUF SD-TUF10A*II-1 2/28/94 0 to .5 Result Q |
|--|---|--|---|--|---|--|---|--|---|
| VOLATILE ORGANICS | | | | | | | | | |
| HALOGENATED | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | 0.155 U | 0.135 U | 1.2 U | 0.15 U | 0.06 U | 0.15 U | 17.5 U | 7 U | NA |
| 8240S CHLOROBENZENE | 0.155 U | 0.063 J | 34 | 28 | 0.06 U | 0.078 J | 430 | 360 J | 0.0031 U |
| 8240S TRANS-1,2-DICHLOROETHENE | 0.155 U | 0.135 U | 1.2 U | 0.15 U | 0.06 U | 0.15 U | 17.5 U | 7 U | NA |
| AROMATICS | | | | | | | | | |
| 8240S BENZENE | 0.155 U | 0.135 U | 1.2 U | 0.088 J | 0.06 U | 0.15 U | 17.5 U | 7 U | NA |
| 8240S ETHYLBENZENE | 0.155 U | 0.135 U | 1.2 U | 0.061 J | 0.06 U | 0.15 U | 17.5 U | 7 U | NA |
| 8240S M&P-XYLENE | 0.155 U | 0.135 U | 1.2 U | 1 J | 0.06 U | 0.15 U | 17.5 U | 8.2 J | NA |
| 8240S NAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | 0.0031 U |
| 8240S O-XYLENE | 0.155 U | 0.059 J | 1.2 U | 0.23 J | 0.06 U | 0.15 U | 17.5 U | 7 U | NA |
| 8240S TOLUENE | 0.078 J | 0.7 | 1.2 U | 0.87 J | 0.035 J | 0.1 J | 860 | 470 J | 0.0031 U |
| KETONES / ALDEHYDES | | | | | | | | | |
| 8240S 2-BUTANONE | 0.31 U | 0.27 U | 2.4 U | 0.305 U | 0.12 U | 0.74 | 35.5 U | 13.5 U | NA |
| 8240S 2-HEXANONE | 0.31 U | 0.27 U | 2.4 U | 0.305 U | 0.12 U | 0.38 J | 35.5 U | 13.5 U | NA |
| 8240S 4-METHYL-2-PENTANONE | 0.31 U | 0.27 U | 2.4 U | 0.305 U | 0.12 U | 0.26 J | 35.5 U | 13.5 U | NA |
| 8240S ACETONE | 0.31 U | 0.27 U | 2.4 U | 0.305 U | 0.12 U | 0.64 | 35.5 U | 13.5 U | NA |
| SEMI-VOLATILE ORGANICS | | | | | | | | | |
| PAHs | | | | | | | | | |
| 8270S ACENAPHTHENE | 0.28 J | 0.23 J | 0.18 J | 0.36 J | 0.6 U | 1.45 U | 14.5 U | R | NA |
| 8270S ACENAPHTHYLENE | 0.089 J | 0.11 J | 2.35 U | 1.5 U | 0.6 U | 1.45 U | 14.5 U | R | NA |
| 8270S ANTHRACENE | 0.75 J | 0.53 J | 0.44 J | 0.93 J | 0.052 J | 0.29 J | 14.5 U | R | NA |
| 8270S BENZO(A)ANTHRACENE | 3.8 | 3.6 | 2.4 J | 3.2 | 0.26 J | 1.8 J | 14.5 U | R | NA |
| 8270S BENZO(A)PYRENE | 4.1 | 3.5 | 2.4 J | 3.6 | 0.6 U | 1.4 J | 14.5 U | R | NA |
| 8270S BENZO(B)FLUORANTHENE | 8.9 | 6.9 | 6 | 6.5 | 0.44 J | 2.8 J | 14.5 U | R | NA |
| 8270S BENZO(G,H,I)PERYLENE | 4.8 | 3.2 | 3 J | 3.3 | 0.6 U | 1.7 J | 14.5 U | R | NA |
| 8270S BENZO(K)FLUORANTHENE | 9.3 | 7.7 | 6.3 | 7.3 | 0.46 J | 3.1 | 14.5 U | R | NA |
| 8270S CHRYSENE | 6.9 | 6.1 | 4 J | 5.2 | 0.31 J | 2.2 J | 14.5 U | R | NA |
| 8270S DIBENZO(A,H)ANTHRACENE | 1.45 U | 1.3 J | 2.35 U | 1.5 J | 0.6 U | 0.62 J | 14.5 U | R | NA |
| 8270S FLUORANTHENE | 10 | 14 | 8.4 | 11 | 0.48 J | 5.3 | 4.5 J | R | NA |
| 8270S FLUORENE | 0.79 J | 0.64 J | 0.43 J | 0.67 J | 0.6 U | 0.13 J | 14.5 U | R | NA |
| 8270S INDENO(1,2,3-CD)PYRENE | 4.3 | 2.9 | 3 J | 3 | 0.6 U | 1.4 J | 14.5 U | R | NA |
| 8270S 2-METHYLNAPHTHALENE | 0.68 J | 0.44 J | 0.94 J | 2.1 J | 0.8 U | 1.45 U | 4.7 J | R | NA |
| 8270S NAPHTHALENE | R | 0.68 J | 2.35 U | 1.3 J | 0.8 U | 1.45 U | 100 | 79 J | NA |
| 8270S PHENANTHRENE | 6.2 | 4.5 | 2.7 J | 3.9 | 0.19 J | 1.7 J | 3.7 J | R | NA |
| 8270S PYRENE | 11 | 6.3 | 6.8 | 9.9 | 0.46 J | 1.9 J | 4.7 J | R | NA |
| PHTHALATES | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 3 | 1.3 U | 28 | 1.5 U | 0.46 J | 1.45 U | 110 | 130 U | 3.2 |
| 8270S BUTYLBENZYLPHTHALATE | 1.45 U | 1.3 U | 2.35 U | 1.5 U | 0.6 U | 1.45 U | 14.5 U | R | NA |
| 8270S DI-N-BUTYLPHTHALATE | 1.45 U | 1.3 U | 2.35 U | 1.5 U | 0.6 U | 1.45 U | 14.5 U | 8.7 J | NA |
| 8270S DI-N-OCTYLPHTHALATE | 1.45 U | 1.3 U | 2.35 U | 1.6 J | 0.6 U | 1.45 U | 5 J | R | NA |
| 8270S DIMETHYLPHTHALATE | R | 1.3 U | 2.35 U | 1.5 U | 0.6 U | 1.45 U | 290 | R | NA |
| HALOGENATED | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | 1.45 U | 1.3 U | 2.35 U | 0.4 J | 0.6 U | 1.45 U | 14.5 U | R | NA |
| 8270S 1,2-DICHLOROBENZENE | 0.24 J | 0.22 J | 0.67 J | 4.6 | 0.6 U | 1.45 U | 2.5 J | R | NA |
| 8270S 1,3-DICHLOROBENZENE | 1.45 U | 1.3 U | 2.35 U | 0.69 J | 0.6 U | 1.45 U | 14.5 U | R | NA |
| 8270S 1,4-DICHLOROBENZENE | 1.45 U | 1.3 U | 0.59 J | 2.8 J | 0.6 U | 1.45 U | 14.5 U | R | NA |
| 8270S 4-CHLOROANILINE | 1.45 U | 1.3 U | 2.35 U | 1.5 U | 0.6 U | 1.45 U | 7.8 J | 32 J | NA |
| PHENOLS | | | | | | | | | |
| 8270S 2-METHYLPHENOL | 1.45 U | 1.3 U | 2.35 U | 1.5 U | 0.8 U | 1.45 U | 3.3 J | R | NA |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-METHYLPHENOL | 1.45 U | 1.3 U | 2.35 U | 1.5 U | 0.8 U | 0.64 J | 4 J | R | NA |
| 8270S PENTACHLOROPHENOL | 7 U | 6.5 U | 12 U | 7.5 U | 2.95 U | 7.5 U | 12 J | R | NA |
| 8270S PHENOL | 1.45 U | 1.3 U | 2.35 U | 1.5 U | 0.8 U | 1.45 U | 14.5 U | R | NA |
| OTHER | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | 1.45 U | 1.3 U | 2.35 U | 1.5 U | 0.8 U | 1.45 U | 14.5 U | R | NA |
| FINGERPRINT COMPOUNDS | | | | | | | | | |
| 8270S TINUVIN 327 | 7 U | 6.5 U | R | 0.8 J | 2.95 U | 7.5 U | 560 | 2200 J | NA |
| 8270S TINUVIN 328 | NA | NA | NA | NA | NA | NA | NA | NA | 0.205 U |
| PCBs | | | | | | | | | |
| 8080S PCB-1221 | 0.29 U | 2.65 U | 0.23 U | 3.05 U | 0.06 U | 0.03 U | 27 U | 27 U | 0.042 U |
| 8080S PCB-1232 | 0.29 U | 2.65 U | 0.23 U | 3.05 U | 0.06 U | 0.03 U | 27 U | 27 U | 0.0205 U |
| 8080S PCB-1242 | 0.145 U | 1.35 U | 0.115 U | 1.55 U | 0.0295 U | 0.015 U | 13.5 U | 13.5 U | 0.0205 U |
| 8080S PCB-1248 | 0.145 U | 1.35 U | 0.62 | 1.55 U | 0.0295 U | 0.015 U | 390 J | 13.5 U | 0.0205 U |
| 8080S PCB-1254 | 0.29 U | 2.65 U | 6.2 | 3.05 U | 0.06 U | 0.03 U | 260 J | 210 | 0.0205 U |
| 8080S PCB-1260 | 0.29 U | 2.65 U | 0.23 U | 3.05 U | 0.06 U | 0.03 U | 27 U | 27 U | 0.021 J |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | |
| 8080S 4,4'-DDD | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.03 | 1.35 U | 1.35 U | NA |
| 8080S 4,4'-DDE | 0.0145 U | 0.46 | 0.0115 U | 0.155 U | 0.00295 U | 0.024 | 1.35 U | 1.35 U | NA |
| 8080S 4,4'-DDT | 0.029 U | 0.265 U | 0.023 U | 0.67 | 0.006 U | 0.0087 | 2.7 U | 2.7 U | NA |
| 8080S ALDRIN | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.0015 U | 1.35 U | 1.35 U | NA |
| 8080S ALPHA-BHC | 0.038 | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.0015 U | 1.35 U | 1.35 U | NA |
| 8080S ALPHA-CHLORDANE | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.018 | 1.35 U | 1.35 U | NA |
| 8080S BETA-BHC | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.0015 U | 1.35 U | 1.35 U | NA |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S DIELDRIN | 0.032 | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.0015 U | 1.35 U | 1.35 U | NA |
| 8080S ENDOSULFAN I | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.0015 U | 1.35 U | 1.35 U | NA |
| 8080S ENDOSULFAN II | 0.0435 U | 0.4 | 0.0345 U | 0.46 U | 0.009 U | 0.0045 U | 4.06 U | 4 U | NA |
| 8080S ENDOSULFAN SULFATE | 0.075 U | 0.65 U | 0.06 U | 0.75 U | 0.015 U | 0.0075 U | 6.5 U | 6.5 U | NA |
| 8080S ENDRIN | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.003 | 1.35 U | 1.35 U | NA |
| 8080S ENDRIN ALDEHYDE | 0.029 U | 0.265 U | 0.023 U | 0.305 U | 0.006 U | 0.006 U | 2.7 U | 2.7 U | NA |
| 8080S GAMMA-BHC | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.021 | 1.35 U | 1.35 U | NA |
| 8080S GAMMA-CHLORDANE | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.022 | 1.35 U | 1.35 U | NA |
| 8080S HEPTACHLOR | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.0064 | 1.35 U | 1.35 U | NA |
| 8080S HEPTACHLOR EPOXIDE | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.0015 U | 1.35 U | 1.35 U | NA |
| 8080S KEPONE | 0.0145 U | 0.135 U | 0.0115 U | 0.155 U | 0.00295 U | 0.0015 U | 1.35 U | 1.35 U | NA |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | |
| 8142S DISULFOTON | 0.145 U | 0.135 U | 0.465 U | 0.15 U | 0.145 U | 0.145 U | 0.55 U | 0.135 U | NA |
| 8142S METHYL PARATHION | 0.0215 U | 0.02 U | 0.07 U | 0.0225 U | 0.0215 U | 0.022 U | 0.085 U | 0.0205 U | NA |
| HERBICIDES | | | | | | | | | |
| 8152S 2,4-D | 0.17 U | 0.16 U | 0.27 U | 0.18 U | 0.07 U | 0.165 U | 0.85 U | 0.92 J | NA |
| 8152S DINOSEB | 0.0215 U | 0.0195 U | 0.034 U | 0.0225 U | 0.009 U | 0.021 U | 0.105 U | 0.08 U | NA |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | |
| 8270S DCDF | 0.5 J | 2.6 U | 4.7 U | 2.95 U | 1.2 U | 2.9 U | 28.5 U | R | NA |
| 8270S DIBENZOFURAN | 0.28 J | 0.23 J | 0.23 J | 0.32 J | 0.6 U | 1.45 U | 14.5 U | R | NA |
| 8270S TRCDF | 2.9 U | 2.6 U | 4.7 U | 2.95 U | 1.2 U | 2.9 U | 28.5 U | R | NA |
| 80W2S 1,2,3,4,6,7,8-HPCLD | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 80W2S 1,2,3,4,6,7,8-HPCLF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 80W2S 1,2,3,4,7,8,9-HPCLF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 80W2S 1,2,3,4,7,8-HXCLF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 80W2S 1,2,3,6,7,8-HXCLF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 80W2S 2,3,7,8-TCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 80W2S HPCDD | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 80W2S HPCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 80W2S HXCLF | R | R | R | R | R | R | R | R | NA |
| 80W2S OCDD | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 80W2S OCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 80W2S TCDF | R | R | R | R | R | R | R | R | NA |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-9
CRANSTON SITE
UPPER FACILITY REACH
SURFACE RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TUF | TUF | UPPER FACILITY REACH SUMMARY | | | | |
|--|----------------|----------------|------------------------------|---------------------|---|---------------------|---------------------|
| | SD-TUF10B*II-1 | SD-TUF10C*II-1 | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| | 2/28/94 | 2/28/94 | | | | | |
| | 0 to .5 | 0 to .5 | | | | | |
| Result Q | Result Q | | | | | | |
| VOLATILE ORGANICS | | | | | | | |
| HALOGENATED | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | 0 | | | | |
| 8240S CHLOROBENZENE | 0.00285 U | 0.031 U | 6 | 142 | 77.3 | 430 | 0.063 |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | 0 | | | | |
| AROMATICS | | | | | | | |
| 8240S BENZENE | NA | NA | 1 | 0.086 | 3.29 | 0.086 | 0.086 |
| 8240S ETHYLBENZENE | NA | NA | 1 | 0.061 | 3.28 | 0.061 | 0.061 |
| 8240S M&P-XYLENE | NA | NA | 2 | 4.6 | 3.55 | 8.2 | 1 |
| 8240S NAPHTHALENE | 0.00285 U | 0.00325 U | 0 | | | | |
| 8240S O-XYLENE | NA | NA | 2 | 0.145 | 3.29 | 0.23 | 0.059 |
| 8240S TOLUENE | 0.00285 U | 0.00325 U | 7 | 190 | 121 | 860 | 0.035 |
| KETONES / ALDEHYDES | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | 1 | 0.74 | 6.64 | 0.74 | 0.74 |
| 8240S 2-HEXANONE | NA | NA | 1 | 0.38 | 6.6 | 0.38 | 0.38 |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | 1 | 0.26 | 6.58 | 0.26 | 0.26 |
| 8240S ACETONE | NA | NA | 1 | 0.64 | 6.63 | 0.64 | 0.64 |
| SEMI-VOLATILE ORGANICS | | | | | | | |
| PAHs | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | 4 | 0.263 | 2.51 | 0.36 | 0.18 |
| 8270S ACENAPHTHYLENE | NA | NA | 2 | 0.0995 | 2.94 | 0.11 | 0.089 |
| 8270S ANTHRACENE | NA | NA | 8 | 0.499 | 2.5 | 0.93 | 0.052 |
| 8270S BENZO(A)ANTHRACENE | NA | NA | 8 | 2.48 | 4.19 | 3.8 | 0.26 |
| 8270S BENZO(A)PYRENE | NA | NA | 5 | 3 | 4.3 | 4.1 | 1.4 |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | 6 | 5.26 | 6.58 | 8.9 | 0.44 |
| 8270S BENZO(G,H,I)PERYLENE | NA | NA | 5 | 3.2 | 4.44 | 4.8 | 1.7 |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | 6 | 5.69 | 6.95 | 9.3 | 0.46 |
| 8270S CHRYSENE | NA | NA | 8 | 4.12 | 5.6 | 6.9 | 0.31 |
| 8270S DIBENZO(A,H)ANTHRACENE | NA | NA | 3 | 1.14 | 3.19 | 1.5 | 0.62 |
| 8270S FLUORANTHENE | NA | NA | 7 | 7.38 | 7.38 | 14 | 0.48 |
| 8270S FLUORENE | NA | NA | 5 | 0.532 | 2.54 | 0.79 | 0.13 |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | 5 | 2.92 | 4.24 | 4.3 | 1.4 |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | 5 | 1.77 | 1.56 | 4.7 | 0.44 |
| 8270S NAPHTHALENE | NA | NA | 4 | 45.2 | 26.5 | 100 | 0.68 |
| 8270S PHENANTHRENE | NA | NA | 7 | 3.27 | 3.27 | 6.2 | 0.19 |
| 8270S PYRENE | NA | NA | 7 | 4.87 | 4.87 | 11 | 0.46 |
| PHTHALATES | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 18 | 6.7 | 7 | 24.2 | 27.6 | 110 | 0.46 |
| 8270S BUTYLBENZYL PHTHALATE | NA | NA | 0 | | | | |
| 8270S DI-N-BUTYL PHTHALATE | NA | NA | 1 | 8.7 | 3.98 | 8.7 | 8.7 |
| 8270S DI-N-OCTYL PHTHALATE | NA | NA | 2 | 3.3 | 1.96 | 5 | 1.6 |
| 8270S DIMETHYL PHTHALATE | NA | NA | 1 | 290 | 49.5 | 290 | 290 |
| HALOGENATED | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | 1 | 0.4 | 3.15 | 0.4 | 0.4 |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | 5 | 1.65 | 1.47 | 4.6 | 0.22 |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | 1 | 0.69 | 3.19 | 0.69 | 0.69 |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | 2 | 1.7 | 3.24 | 2.8 | 0.59 |
| 8270S 4-CHLOROANILINE | NA | NA | 2 | 19.9 | 6.06 | 32 | 7.8 |
| PHENOLS | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | 1 | 3.3 | 1.71 | 3.3 | 3.3 |
| 8270S 3&4-METHYLPHENOL | NA | NA | 0 | | | | |
| 8270S 4-METHYLPHENOL | NA | NA | 2 | 2.32 | 1.69 | 4 | 0.64 |
| 8270S PENTACHLOROPHENOL | NA | NA | 1 | 12 | 7.92 | 12 | 12 |
| 8270S PHENOL | NA | NA | 0 | | | | |
| OTHER | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | NA | NA | 0 | | | | |
| FINGERPRINT COMPOUNDS | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | 8 | 920 | 398 | 2200 | 0.8 |
| 8270S TINUVIN 328 | 0.19 U | 0.215 U | 0 | | | | |
| PCBs | | | | | | | |
| 8080S PCB-1221 | 0.0385 U | 0.0436 U | 0 | | | | |
| 8080S PCB-1232 | 0.019 U | 0.0215 U | 0 | | | | |
| 8080S PCB-1242 | 0.019 U | 0.0215 U | 0 | | | | |
| 8080S PCB-1248 | 0.019 U | 0.0215 U | 2 | 195 | 37 | 390 | 0.62 |
| 8080S PCB-1264 | 0.019 U | 0.0215 U | 3 | 159 | 43.8 | 260 | 6.2 |
| 8080S PCB-1280 | 0.019 U | 0.0215 U | 1 | 0.021 | 5.49 | 0.021 | 0.021 |
| ORGANOCHLORINE PESTICIDES | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | 1 | 0.03 | 0.381 | 0.03 | 0.03 |
| 8080S 4,4'-DDE | NA | NA | 2 | 0.242 | 0.421 | 0.46 | 0.024 |
| 8080S 4,4'-DDT | NA | NA | 2 | 0.339 | 0.8 | 0.67 | 0.0087 |
| 8080S ALDRIN | NA | NA | 0 | | | | |
| 8080S ALPHA-BHC | NA | NA | 1 | 0.038 | 0.38 | 0.038 | 0.038 |
| 8080S ALPHA-CHLORDANE | NA | NA | 1 | 0.018 | 0.38 | 0.018 | 0.018 |
| 8080S BETA-BHC | NA | NA | 0 | | | | |
| 8080S CHLOROBENZILATE | NA | NA | 0 | | | | |
| 8080S DIELDRIN | NA | NA | 1 | 0.032 | 0.38 | 0.032 | 0.032 |
| 8080S ENDOSULFAN I | NA | NA | 0 | | | | |
| 8080S ENDOSULFAN II | NA | NA | 0 | | | | |
| 8080S ENDOSULFAN SULFATE | NA | NA | 0 | | | | |
| 8080S ENDRIN | NA | NA | 1 | 0.003 | 0.378 | 0.003 | 0.003 |
| 8080S ENDRIN ALDEHYDE | NA | NA | 0 | | | | |
| 8080S GAMMA-BHC | NA | NA | 1 | 0.021 | 0.38 | 0.021 | 0.021 |
| 8080S GAMMA-CHLORDANE | NA | NA | 1 | 0.022 | 0.38 | 0.022 | 0.022 |
| 8080S HEPTACHLOR | NA | NA | 1 | 0.0054 | 0.378 | 0.0054 | 0.0054 |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | 0 | | | | |
| 8080S KEPONE | NA | NA | 0 | | | | |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | |
| 8142S DISULFOTON | NA | NA | 0 | | | | |
| 8142S METHYL PARATHION | NA | NA | 0 | | | | |
| HERBICIDES | | | | | | | |
| 8162S 2,4-D | NA | NA | 1 | 0.92 | 0.348 | 0.92 | 0.92 |
| 8162S DINOSEB | NA | NA | 0 | | | | |
| CHLORINATED DIOXINS AND FURANS | | | | | | | |
| 8270S DCDF | NA | NA | 1 | 0.5 | 6.19 | 0.5 | 0.5 |
| 8270S DIBENZOFURAN | NA | NA | 4 | 0.265 | 2.52 | 0.32 | 0.23 |
| 8270S TRCDF | NA | NA | 0 | | | | |
| SOWZS 1,2,3,4,6,7,8-HPCDD | 0.000021 U | NA | 0 | | | | |
| SOWZS 1,2,3,4,6,7,8-HPCDF | 0.00006 U | NA | 0 | | | | |
| SOWZS 1,2,3,4,7,8,9-HPCDF | 0.00007 U | NA | 0 | | | | |
| SOWZS 1,2,3,4,7,8-HXCDF | 0.0000296 U | NA | 0 | | | | |
| SOWZS 1,2,3,6,7,8-HXCDF | 0.0000275 U | NA | 0 | | | | |
| SOWZS 2,3,7,8-TCDF | 0.00005 U | NA | 0 | | | | |
| SOWZS HPCDD | 0.000021 U | NA | 0 | | | | |
| SOWZS HPCDF | 0.00006 U | NA | 0 | | | | |
| SOWZS HXCDF | 0.0000275 U | NA | 0 | | | | |
| SOWZS OCDD | 0.00007 U | NA | 0 | | | | |
| SOWZS OCDF | 0.00008 U | NA | 0 | | | | |
| SOWZS TCDF | 0.00005 U | NA | 0 | | | | |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-10
CRANSTON SITE
UPPER FACILITY REACH
SURFACE RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TUF SD-02L*IB-1 11/29/90 0 to .5 | TUF SD-02L*IB-2 3/26/91 0 to .5 | TUF SD-02R*IB-1 11/28/90 0 to .5 | TUF SD-02R*IB-2 3/26/91 0 to .5 | TUF SD-03L*IB-1 11/29/90 0 to .5 | TUF SD-03L*IB-2 3/27/91 0 to .5 | TUF SD-03R*IB-1 11/28/90 0 to .5 | TUF SD-03R*IB-2 3/28/91 0 to .5 | TUF SD-TUF10A*II-1 2/28/94 0 to .5 | TUF SD-TUF10B*II-1 2/28/94 0 to .5 | TUF SD-TUF10C*II-1 2/28/94 0 to .5 | UPPER FACILITY REACH SUMMARY | | | | |
|---|---|--|---|--|---|--|---|--|---|---|---|------------------------------|---------------------|---|---------------------|---------------------|
| | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| 6010S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 7041S ANTIMONY | 0.8 U | 0.8 U | 6.9 J | 1.6 J | 0.34 U | 0.65 U | 5.4 J | 0.55 U | NA | NA | NA | 3 | 4.63 | 2.13 | 6.9 | 1.6 |
| 6010S BARIUM | 378 J | 269 J | 380 J | 220 J | 19.3 J | 247 J | 126 J | 122 J | NA | NA | NA | 8 | 220.00 | 220.00 | 380 | 19.3 |
| 6010S BERYLLIUM | 4 | 3.8 J | 4.2 | 2.3 J | 0.5 | 2 J | 2 | 2 J | NA | NA | NA | 8 | 2.60 | 2.60 | 4.2 | 0.5 |
| 6010S CADMIUM | 8.7 | 5.3 J | 15.3 | 22 J | 0.72 | 6.5 J | 9.7 | 11 J | NA | NA | NA | 8 | 9.90 | 9.90 | 22 | 0.72 |
| 6010S CALCIUM | 4630 J | 3380 J | 5720 J | 3810 J | 691 J | 2460 J | 3010 J | 2940 J | NA | NA | NA | 8 | 3330.00 | 3330.00 | 5720 | 691 |
| 6010S CHROMIUM | 1260 J | 715 J | 394 J | 565 J | 13.9 J | 64.6 J | 463 J | 395 J | NA | NA | NA | 8 | 484.00 | 484.00 | 1260 | 13.9 |
| 6010S COBALT | 11 J | 10.6 | 10.6 J | 8.2 | 2.3 J | 9.1 | 7.4 J | 10.2 | NA | NA | NA | 8 | 8.68 | 8.68 | 11 | 2.3 |
| 6010S COPPER | 1080 J | 516 J | 953 J | 947 J | 15.1 J | 98.6 J | 337 J | 306 J | 30 | 23.2 | 99.5 | 11 | 400.00 | 400.00 | 1080 | 15.1 |
| 6010S IRON | 26500 | 22300 | 24300 | 23300 | 6010 | 18100 | 21300 | 27700 | NA | NA | NA | 8 | 21200.00 | 21200.00 | 27700 | 6010 |
| 6010S MAGNESIUM | 3950 J | 3730 | 3010 J | 2250 | 898 J | 2200 | 2720 J | 3200 | NA | NA | NA | 8 | 2740.00 | 2740.00 | 3950 | 898 |
| 6010S MANGANESE | 377 J | 320 | 394 J | 514 | 93.9 J | 574 | 315 J | 369 | NA | NA | NA | 8 | 370.00 | 370.00 | 574 | 93.9 |
| 6010S NICKEL | 38.7 | 27.1 J | 166 | 125 J | 3.2 U | 29.1 J | 34.7 | 31.5 J | NA | NA | NA | 7 | 64.60 | 56.90 | 166 | 27.1 |
| 6010S POTASSIUM | 1950 | 1920 | 1610 | 1080 | 599 | 1650 | 1590 | 2040 | NA | NA | NA | 8 | 1550.00 | 1550.00 | 2040 | 599 |
| 6010S SILVER | 2.3 | 4.6 J | 17.1 | 8.8 J | 0.47 U | 1.25 U | 1.25 U | 0.95 U | 0.65 U | 0.6 U | 0.65 U | 4 | 8.20 | 3.51 | 17.1 | 2.3 |
| 6010S SODIUM | 158 U | 544 | 952 | 746 | 47 U | 716 | 552 | 561 | NA | NA | NA | 6 | 679.00 | 535.00 | 952 | 544 |
| 6010S TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | | | |
| SNZZS TIN | 59.2 | 9.5 U | 75.2 | 25.6 | 4.7 U | 12.5 U | 12.5 U | 9.5 U | NA | NA | NA | 3 | 53.30 | 26.10 | 75.2 | 25.6 |
| 6010S VANADIUM | 34.7 | 33.8 | 49.4 | 44 | 3.5 | 12.5 | 26.7 | 28.8 | NA | NA | NA | 8 | 29.20 | 29.20 | 49.4 | 3.5 |
| 6010S ZINC | 2150 J | 1070 J | 1770 J | 1460 J | 45.4 J | 221 J | 12100 J | 13900 J | 54.5 | 52.3 | 118 | 11 | 2990.00 | 2990.00 | 13900 | 45.4 |
| 7060S ARSENIC | 23.5 J | 38.2 | 33.7 J | 23 | 1.8 J | 12.8 | 17.7 J | 23.3 | 2.3 J | 4.3 J | 11.9 J | 11 | 17.50 | 17.50 | 38.2 | 1.8 |
| 7421S LEAD | 221 | 375 J | 829 | 594 J | 14.1 | 100 J | 300 | 223 J | 33.2 J | 19 J | 81.1 J | 11 | 254.00 | 254.00 | 829 | 14.1 |
| 747ZS MERCURY | 0.83 J | 2.8 | 0.38 J | 1 | 0.028 U | 0.25 | 0.88 J | 1.4 | NA | NA | NA | 7 | 1.08 | 0.95 | 2.8 | 0.25 |
| 7740S SELENIUM | 0.55 U | 1.16 | 1 U | 0.974 | 0.245 U | 0.936 | 0.6 U | 0.802 | NA | NA | NA | 4 | 0.97 | 0.78 | 1.16 | 0.802 |
| 7841S THALLIUM | 0.55 U | 1.16 | 1 U | 0.974 | 0.245 U | 0.936 | 0.6 U | 0.802 | NA | NA | NA | 4 | 0.97 | 0.78 | 1.16 | 0.802 |
| 9010S CYANIDE | 22.1 | 25.6 | 31.4 | 13.2 | 0.26 U | 2.8 | 12 | 3 | NA | NA | NA | 7 | 15.70 | 13.80 | 31.4 | 2.8 |
| 9030S SULFIDE | 120 | 65 U | 2000 | 75 U | 49 | 55 U | 17000 | 280 | NA | NA | NA | 5 | 3890.00 | 2460.00 | 17000 | 49 |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-11
CRANSTON SITE
UPPER FACILITY REACH
SHALLOW RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TUF SD-DUP1*II-2 7/25/94 1 to 2 Result Q | TUF SD-DUP2*II-1 2/23/94 1 to 2 Result Q | TUF SD-DUP3*II-1 2/23/94 1 to 2 Result Q | TUF SD-TUF-1E(1-2)*II-2 7/26/94 1 to 2 Result Q | TUF SD-TUF-6D(1-2)*II-2 7/26/94 1 to 2 Result Q | TUF SD-TUF-7D(1-2)*II-2 7/25/94 1 to 2 Result Q | TUF SD-TUF-8D(1-2)*II-2 7/25/94 1 to 2 Result Q | TUF SD-TUF1A(S)*II-1 2/22/94 1 to 2 Result Q | TUF SD-TUF1B(S)*II-1 2/22/94 1 to 2 Result Q |
|--|--|--|--|---|---|---|---|--|--|
| VOLATILE ORGANICS | | | | | | | | | |
| HALOGENATED | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S CHLOROBENZENE | 12 J | 0.13 J | 0.19 J | 0.0031 U | 0.00285 U | 0.0031 U | 20 J | 0.0034 U | 0.00285 U |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| AROMATICS | | | | | | | | | |
| 8240S BENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ETHYLBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S M&P-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S NAPHTHALENE | 0.009 J | 0.0039 U | 0.00395 U | 0.0031 U | 0.00285 U | 0.0031 U | 0.0086 J | 0.0034 U | 0.00265 U |
| 8240S O-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S TOLUENE | 0.00405 U | 0.0039 U | 0.00395 U | 0.0031 U | 0.00285 U | 0.0031 U | 0.0036 U | 0.0034 U | 0.00265 U |
| KETONES / ALDEHYDES | | | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 2-HEXANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ACETONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SEMI-VOLATILE ORGANICS | | | | | | | | | |
| PAHs | | | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ACENAPHTHYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(C,H,I)PERYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S CHRYSENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S NAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENANTHRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHTHALATES | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 40 | 0.26 U | 0.26 U | 0.205 U | 0.33 J | 0.079 J | 29 | 1.1 J | 0.175 U |
| 8270S BUTYLBENZYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-BUTYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-OCTYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIMETHYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HALOGENATED | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-CHLOROANILINE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHENOLS | | | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PENTACHLOROPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| OTHER | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| FINGERPRINT COMPOUNDS | | | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TINUVIN 328 | 0.265 U | 0.28 U | 0.26 U | 0.205 U | 0.185 U | 0.205 U | 0.24 U | 0.225 U | 0.175 U |
| PCBs | | | | | | | | | |
| 8080S PCB-1221 | 0.55 U | 0.05 U | 0.0515 U | 0.041 U | 0.0375 U | 0.041 U | 0.0485 U | 0.0335 U | 0.0355 U |
| 8080S PCB-1232 | 0.265 U | 0.0255 U | 0.0255 U | 0.02 U | 0.0185 U | 0.02 U | 0.024 U | 0.0165 U | 0.0175 U |
| 8080S PCB-1242 | 0.265 U | 0.0255 U | 0.0255 U | 0.02 U | 0.0185 U | 0.02 U | 0.024 U | 0.0165 U | 0.0175 U |
| 8080S PCB-1248 | 3.6 | 0.0255 U | 0.0255 U | 0.02 U | 0.36 | 0.02 U | 2.2 | 0.046 J | 0.083 |
| 8080S PCB-1254 | 13 J | 0.023 J | 0.13 | 0.02 U | 0.0185 U | 0.02 U | 0.024 U | 0.13 J | 0.0175 U |
| 8080S PCB-1260 | 0.265 U | 0.0255 U | 0.11 J | 0.02 U | 0.0185 U | 0.02 U | 0.13 J | 0.0165 U | 0.0175 U |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S BETA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S DIELDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN I | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN II | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN SULFATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN ALDEHYDE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S KEPONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | |
| 8142S DISULFOTON | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8142S METHYL PARATHION | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HERBICIDES | | | | | | | | | |
| 8162S 2,4-D | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8162S DINOSEB | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | |
| 8270S DCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZOFURAN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TRCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS 1,2,3,4,6,7,8-HPCDD | NA | 0.000185 U | 0.00012 F | NA | NA | NA | NA | 0.00028 F | NA |
| SOWZS 1,2,3,4,6,7,8-HPCDF | NA | 0.00015 J | 0.00018 J | NA | NA | NA | NA | 0.00065 J | NA |
| SOWZS 1,2,3,4,7,8,9-HPCDF | NA | 0.00006 U | 0.000095 U | NA | NA | NA | NA | 0.000105 U | NA |
| SOWZS 1,2,3,4,7,8-HXCDF | NA | 0.000043 U | 0.000047 U | NA | NA | NA | NA | 0.00022 U | NA |
| SOWZS 1,2,3,6,7,8-HXCDF | NA | 0.0000365 U | 0.0000395 U | NA | NA | NA | NA | 0.0002 U | NA |
| SOWZS 2,3,7,8-TCDF | NA | 0.000115 U | 0.00011 U | NA | NA | NA | NA | 0.000125 U | NA |
| SOWZS HPCDD | NA | 0.000185 U | 0.00024 J | NA | NA | NA | NA | 0.00049 F | NA |
| SOWZS HPCDF | NA | 0.00018 J | 0.00021 J | NA | NA | NA | NA | 0.00073 J | NA |
| SOWZS HXCDF | NA | 0.00012 J | 0.00017 J | NA | NA | NA | NA | 0.0002 U | NA |
| SOWZS OCDD | NA | 0.00019 F | 0.0012 J | NA | NA | NA | NA | 0.0028 J | NA |
| SOWZS OCDF | NA | 0.00011 F | 0.00021 J | NA | NA | NA | NA | 0.00068 J | NA |
| SOWZS TCDF | NA | 0.000115 U | 0.00011 U | NA | NA | NA | NA | 0.000125 U | NA |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-11
CRANSTON SITE
UPPER FACILITY REACH
SHALLOW RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TUF SD-TUF1C(S)*II-1 2/22/94 1 to 2 Result Q | TUF SD-TUF2B(S)*II-1 3/1/94 1 to 2 Result Q | TUF SD-TUF2C(S)*II-1 3/1/94 1 to 2 Result Q | TUF SD-TUF3A(S)*II-1 2/23/94 1 to 2 Result Q | TUF SD-TUF3B(S)*II-1 2/23/94 1 to 2 Result Q | TUF SD-TUF3C(S)*II-1 2/23/94 1 to 2 Result Q | TUF SD-TUF4A(S)*II-1 2/24/94 1 to 2 Result Q | TUF SD-TUF4B(S)*II-1 2/24/94 1 to 2 Result Q | TUF SD-TUF4C(S)*II-1 2/24/94 1 to 2 Result Q |
|--|--|---|---|--|--|--|--|--|--|
| VOLATILE ORGANICS | | | | | | | | | |
| HALOGENATED | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S CHLOROBENZENE | 0.00265 U | 0.0031 U | 110 J | 0.057 J | 0.003 U | 0.01 | 0.22 | 0.02 | 0.0028 U |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| AROMATICS | | | | | | | | | |
| 8240S BENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ETHYLBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S M&P-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S NAPHTHALENE | 0.00265 U | 0.0031 U | 6.5 U | 0.0049 U | 0.003 U | 0.0029 U | 0.0039 U | 0.00325 U | 0.0028 U |
| 8240S O-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S TOLUENE | 0.00265 U | 0.0031 U | 48 J | 0.0049 U | 0.003 U | 0.0029 U | 0.0039 U | 0.00325 U | 0.0028 U |
| KETONES / ALDEHYDES | | | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 2-HEXANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ACETONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SEMI-VOLATILE ORGANICS | | | | | | | | | |
| PAHs | | | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ACENAPHTHYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(G,H,I)PERYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S CHRYSENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S NAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENANTHRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHTHALATES | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 0.85 J | 0.4 J | 3.1 J | 0.285 U | 0.195 U | 0.19 U | 0.26 U | 9.2 J | 1.1 |
| 8270S BUTYLBENZYLPHthalATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-BUTYLPHthalATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-OCTYLPHthalATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIMETHYLPHthalATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HALOGENATED | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-CHLOROANILINE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHENOLS | | | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PENTACHLOROPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| OTHER | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| FINGERPRINT COMPOUNDS | | | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TINUVIN 328 | 0.175 U | 5 J | 110 | 0.285 U | 0.195 U | 0.19 U | 0.26 U | 0.215 U | 2.2 |
| PCBs | | | | | | | | | |
| 8080S PCB-1221 | 0.035 U | 0.415 U | 56 | 0.051 U | 0.0395 U | 0.39 U | 0.05 U | 0.0435 U | 0.0375 U |
| 8080S PCB-1232 | 0.017 U | 0.205 U | 1.1 U | 0.0285 U | 0.0195 U | 0.19 U | 0.026 U | 0.0215 U | 0.0185 U |
| 8080S PCB-1242 | 0.017 U | 0.205 U | 1.1 U | 0.0285 U | 0.0195 U | 0.19 U | 0.026 U | 0.0215 U | 0.0185 U |
| 8080S PCB-1248 | 0.038 | 2.1 J | 1.1 U | 0.0285 U | 0.0195 U | 0.19 U | 0.026 U | 0.0215 U | 0.0185 U |
| 8080S PCB-1254 | 0.017 U | 0.205 U | 14 | 0.021 J | 0.0195 U | 2.3 | 0.093 | 0.08 J | 0.081 |
| 8080S PCB-1260 | 0.017 U | 0.205 U | 5 | 0.0285 U | 0.0195 U | 0.19 U | 0.11 J | 0.032 J | 0.0185 U |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S BETA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S DIELDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN I | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN II | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN SULFATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN ALDEHYDE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S KEPONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | |
| 8142S DISULFOTON | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8147S METHYL PARATHION | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HERBICIDES | | | | | | | | | |
| 8152S 2,4-D | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8152S DINOSEB | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | |
| 8270S DCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZOFURAN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TRCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS 1,2,3,4,6,7,8-HPCDD | NA | NA | 0.0000365 U | 0.00004 U | NA | NA | 0.00021 J | NA | NA |
| SOWZS 1,2,3,4,6,7,8-HPCDF | NA | NA | 0.00006 U | 0.00017 J | NA | NA | 0.00024 J | NA | NA |
| SOWZS 1,2,3,4,7,8,9-HPCDF | NA | NA | 0.000065 U | 0.00006 U | NA | NA | 0.00036 U | NA | NA |
| SOWZS 1,2,3,4,7,8-HXCDF | NA | NA | 0.00003 U | 0.0000375 U | NA | NA | 0.00007 U | NA | NA |
| SOWZS 1,2,3,6,7,8-HXCDF | NA | NA | 0.000028 U | 0.0000315 U | NA | NA | 0.00006 U | NA | NA |
| SOWZS 2,3,7,8-TCDF | NA | NA | 0.00006 U | 0.000075 U | NA | NA | 0.00012 U | NA | NA |
| SOWZS HPCDD | NA | NA | 0.0000365 U | 0.00004 U | NA | NA | 0.0004 J | NA | NA |
| SOWZS HPCDF | NA | NA | 0.00006 U | 0.0002 J | NA | NA | 0.00053 J | NA | NA |
| SOWZS HXCDF | NA | NA | 0.000028 U | 0.00013 J | NA | NA | 0.00021 J | NA | NA |
| SOWZS OCDD | NA | NA | 0.00024 U | 0.00018 U | NA | NA | 0.0021 J | NA | NA |
| SOWZS OCDF | NA | NA | 0.00006 U | 0.0001 F | NA | NA | 0.00036 J | NA | NA |
| SOWZS TCDF | NA | NA | 0.00006 U | 0.000075 U | NA | NA | 0.00012 U | NA | NA |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-11
CRANSTON SITE
UPPER FACILITY REACH
SHALLOW RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TUF SD-TUF6A(S)*II-1 2/24/94 1 to 2 Result Q | TUF SD-TUF6B(S)*II-1 2/24/94 1 to 2 Result Q | TUF SD-TUF6C(S)*II-1 2/24/94 1 to 2 Result Q | TUF SD-TUF6A(S)*II-1 2/25/94 1 to 2 Result Q | TUF SD-TUF6B(S)*II-1 2/25/94 1 to 2 Result Q | TUF SD-TUF6C(S)*II-1 2/25/94 1 to 2 Result Q | TUF SD-TUF7A(S)*II-1 2/25/94 1 to 2 Result Q | TUF SD-TUF7B(S)*II-1 2/25/94 1 to 2 Result Q | TUF SD-TUF7C(S)*II-1 2/25/94 1 to 2 Result Q |
|--|--|--|--|--|--|--|--|--|--|
| VOLATILE ORGANICS | | | | | | | | | |
| HALOGENATED | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S CHLOROBENZENE | 0.08 | 0.0031 U | 1900 | 0.00385 U | 0.013 | 0.0028 U | 0.003 U | 0.0072 | 10 J |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| AROMATICS | | | | | | | | | |
| 8240S BENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ETHYLBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S M&P-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S NAPHTHALENE | 0.00346 U | 0.0031 U | 110 J | 0.00385 U | 0.003 U | 0.021 J | 0.003 U | 0.0031 U | 0.12 J |
| 8240S O-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S TOLUENE | 0.00346 U | 0.0031 U | 870 | 0.00385 U | 0.003 U | 0.0028 U | 0.003 U | 0.0031 U | 0.0185 U |
| KETONES / ALDEHYDES | | | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 2-HEXANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ACETONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SEMI-VOLATILE ORGANICS | | | | | | | | | |
| PAHs | | | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ACENAPHTHYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(G,H,I)PERYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S CHRYSENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S NAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENANTHRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHTHALATES | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 0.23 U | 0.19 J | 14 J | 2.6 J | 0.2 U | 0.185 U | 0.12 J | 0.27 J | 60 J |
| 8270S BUTYLBENZYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-BUTYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-OCTYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIMETHYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HALOGENATED | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-CHLOROANILINE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHENOLS | | | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PENTACHLOROPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PIENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| OTHER | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| FINGERPRINT COMPOUNDS | | | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TINUVIN 328 | 0.23 U | 0.205 U | 97 | 0.31 J | 0.2 U | 0.185 U | 0.2 U | 0.205 U | 0.24 U |
| PCBs | | | | | | | | | |
| 8080S PCB-1221 | 0.0465 U | 0.0415 U | 800 U | 0.05 U | 0.2 U | 0.037 U | 0.0405 U | 0.042 U | 0.49 U |
| 8080S PCB-1232 | 0.023 U | 0.0205 U | 385 U | 0.0255 U | 0.1 U | 0.0185 U | 0.02 U | 0.0205 U | 0.24 U |
| 8080S PCB-1242 | 0.023 U | 0.0205 U | 385 U | 0.0255 U | 0.1 U | 0.0185 U | 0.02 U | 0.0205 U | 0.24 U |
| 8080S PCB-1248 | 0.023 U | 0.0205 U | 34000 | 0.0255 U | 1.5 | 0.11 J | 0.02 U | 0.018 J | 32 J |
| 8080S PCB-1254 | 0.023 U | 0.038 J | 385 U | 0.12 | 0.1 U | 0.0185 U | 0.019 J | 0.044 | 0.24 U |
| 8080S PCB-1280 | 0.023 U | 0.021 J | 385 U | 0.0255 U | 0.1 U | 0.0185 U | 0.02 U | 0.025 J | 0.24 U |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S BETA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S DIELDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN I | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN II | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN SULFATE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN ALDEHYDE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S KEFONE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | |
| 8142S DISULFOTON | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8142S METHYL PARATHION | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HERBICIDES | | | | | | | | | |
| 8162S 2,4-D | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8162S DINOSEB | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | |
| 8270S DCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZOFURAN | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TRCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOW2S 1,2,3,4,6,7,8-HPCDD | NA | 0.000022 U | NA | 0.00014 U | NA | NA | NA | NA | NA |
| SOW2S 1,2,3,4,6,7,8-HPCDF | NA | 0.0000285 U | NA | 0.00011 J | NA | NA | NA | NA | NA |
| SOW2S 1,2,3,4,7,8,9-HPCDF | NA | 0.000035 U | NA | 0.00014 U | NA | NA | NA | NA | NA |
| SOW2S 1,2,3,4,7,8-HXCDF | NA | 0.00003 U | NA | 0.00007 U | NA | NA | NA | NA | NA |
| SOW2S 1,2,3,6,7,8-HXCDF | NA | 0.0000245 U | NA | 0.00006 U | NA | NA | NA | NA | NA |
| SOW2S 2,3,7,8-TCDF | NA | 0.00006 U | NA | 0.000047 U | NA | NA | NA | NA | NA |
| SOW2S HPCDD | NA | 0.000022 U | NA | 0.00014 U | NA | NA | NA | NA | NA |
| SOW2S HPCDF | NA | 0.0000285 U | NA | 0.00013 J | NA | NA | NA | NA | NA |
| SOW2S HXCDF | NA | 0.0000245 U | NA | 0.00006 U | NA | NA | NA | NA | NA |
| SOW2S OCDD | NA | 0.00015 F | NA | 0.00043 J | NA | NA | NA | NA | NA |
| SOW2S OCDF | NA | 0.000055 U | NA | 0.00014 F | NA | NA | NA | NA | NA |
| SOW2S TCDF | NA | 0.00006 U | NA | 0.000047 U | NA | NA | NA | NA | NA |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-11
CRANSTON SITE
UPPER FACILITY REACH
SHALLOW RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TUF SD-TUF8A(S)*II-1 2/28/94 1 to 2 Result Q | TUF SD-TUF8C(S)*II-1 2/28/94 1 to 2 Result Q | TUF SD-TUF8A(S)*II-1 2/28/94 1 to 2 Result Q | TUF SD-TUF9B(S)*II-1 2/28/94 1 to 2 Result Q | TUF SD-TUF9C(S)*II-1 2/28/94 1 to 2 Result Q | UPPER FACILITY REACH SUMMARY | | | | |
|--|--|--|--|--|--|------------------------------|---------------------|---|---------------------|---------------------|
| | | | | | | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| VOLATILE ORGANICS | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S CHLOROBENZENE | 0.059 | 0.011 | 0.00295 U | 0.00285 U | 0.0195 U | 16 | 128 | 64.2 | 1900 | 0.0072 |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | 0 | | | | |
| AROMATICS | | | | | | | | | | |
| 8240S BENZENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S ETHYLBENZENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S M&P-XYLENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S NAPHTHALENE | 0.00295 U | 0.003 U | 0.00295 U | 0.00285 U | 0.00285 U | 5 | 22 | 3.65 | 110 | 0.0086 |
| 8240S O-XYLENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S TOLUENE | 0.00295 U | 0.003 U | 0.00295 U | 0.00285 U | 0.00285 U | 2 | 459 | 28.7 | 870 | 48 |
| KETONES / ALDEHYDES | | | | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S 2-HEXANONE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S ACETONE | NA | NA | NA | NA | NA | 0 | | | | |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | |
| PAHs | | | | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S ACENAPHTHYLENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S ANTHRACENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S BENZO(A)PYRENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S BENZO(G,H,I)PERYLENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S CHRYSENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DIBENZ(A,H)ANTHRACENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S FLUORANTHENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S FLUORENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S NAPHTHALENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S PHENANTHRENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S PYRENE | NA | NA | NA | NA | NA | 0 | | | | |
| PHTHALATES | | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 0.195 U | 1.3 | 0.19 U | 0.185 U | 0.185 U | 17 | 9.63 | 5.21 | 60 | 0.079 |
| 8270S BUTYLBENZYLPHTHALATE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DI-N-BUTYLPHTHALATE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DI-N-OCTYLPHTHALATE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DIMETHYLPHTHALATE | NA | NA | NA | NA | NA | 0 | | | | |
| HALOGENATED | | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 4-CHLOROANILINE | NA | NA | NA | NA | NA | 0 | | | | |
| PHENOLS | | | | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 4-METHYLPHENOL | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S PENTACHLOROPHENOL | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S PHENOL | NA | NA | NA | NA | NA | 0 | | | | |
| OTHER | | | | | | | | | | |
| 8270S 6-NITRO-O-TOLUIDINE | NA | NA | NA | NA | NA | 0 | | | | |
| FINGERPRINT COMPOUNDS | | | | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S TINUVIN 328 | 0.195 U | 0.2 U | 0.19 U | 0.185 U | 0.185 U | 5 | 42.9 | 6.88 | 110 | 0.31 |
| PCBs | | | | | | | | | | |
| 8080S PCB-1221 | 0.0395 U | 0.405 U | 0.0395 U | 0.038 U | 0.038 U | 1 | 56 | 26.9 | 56 | 56 |
| 8080S PCB-1232 | 0.0195 U | 0.2 U | 0.0195 U | 0.019 U | 0.019 U | 0 | | | | |
| 8080S PCB-1242 | 0.0195 U | 2 | 0.0195 U | 0.019 U | 0.15 J | 3 | 0.757 | 12.2 | 2 | 0.12 |
| 8080S PCB-1248 | 0.0195 U | 0.2 U | 0.0195 U | 0.019 U | 0.019 U | 14 | 2430 | 1060 | 34000 | 0.016 |
| 8080S PCB-1254 | 0.0195 U | 0.2 U | 0.0195 U | 0.019 U | 0.019 U | 14 | 2.15 | 13 | 14 | 0.019 |
| 8080S PCB-1260 | 0.0195 U | 0.2 U | 0.0195 U | 0.019 U | 0.019 U | 7 | 0.775 | 12.2 | 5 | 0.021 |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S 4,4'-DDE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S 4,4'-DDT | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ALDRIN | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ALPHA-BHC | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ALPHA-CHLORDANE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S BETA-BHC | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S DIELDRIN | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDOSULFAN I | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDOSULFAN II | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDOSULFAN SULFATE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDRIN | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDRIN ALDEHYDE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S GAMMA-BHC | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S GAMMA-CHLORDANE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S HEPTACHLOR | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S KEPONE | NA | NA | NA | NA | NA | 0 | | | | |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | | |
| 8142S DISULFOTON | NA | NA | NA | NA | NA | 0 | | | | |
| 8142S METHYL PARATHION | NA | NA | NA | NA | NA | 0 | | | | |
| HERBICIDES | | | | | | | | | | |
| 8162S 2,4-D | NA | NA | NA | NA | NA | 0 | | | | |
| 8162S DINOSEB | NA | NA | NA | NA | NA | 0 | | | | |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | | |
| 8270S DCDF | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DIBENZOFURAN | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S TRCDF | NA | NA | NA | NA | NA | 0 | | | | |
| SOWZS 1,2,3,4,6,7,8-HPCDD | NA | NA | NA | 0.0000225 U | NA | 3 | 0.000197 | 0.000115 | 0.00026 | 0.00012 |
| SOWZS 1,2,3,4,6,7,8-HPCDF | NA | NA | NA | 0.000049 U | NA | 6 | 0.00025 | 0.000182 | 0.00065 | 0.00011 |
| SOWZS 1,2,3,4,7,8,9-HPCDF | NA | NA | NA | 0.000055 U | NA | 0 | | | | |
| SOWZS 1,2,3,4,7,8-HXCDF | NA | NA | NA | 0.000033 U | NA | 0 | | | | |
| SOWZS 1,2,3,6,7,8-HXCDF | NA | NA | NA | 0.000031 U | NA | 0 | | | | |
| SOWZS 2,3,7,8-TCDF | NA | NA | NA | 0.00008 U | NA | 0 | | | | |
| SOWZS HPCDD | NA | NA | NA | 0.0000225 U | NA | 3 | 0.000377 | 0.000175 | 0.00049 | 0.00024 |
| SOWZS HPCDF | NA | NA | NA | 0.000049 U | NA | 6 | 0.00033 | 0.000235 | 0.00073 | 0.00013 |
| SOWZS HXCDF | NA | NA | NA | 0.000031 U | NA | 4 | 0.000158 | 0.000108 | 0.00021 | 0.00012 |
| SOWZS OCDD | NA | NA | NA | 0.000095 U | NA | 6 | 0.00115 | 0.000821 | 0.0028 | 0.00015 |
| SOWZS OCDF | NA | NA | NA | 0.000075 U | NA | 6 | 0.00025 | 0.000187 | 0.00058 | 0.0001 |
| SOWZS TCDF | NA | NA | NA | 0.00008 U | NA | 0 | | | | |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-12
CRANSTON SITE
UPPER FACILITY REACH
SHALLOW RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TUF SD-DUP1*II-2 7/25/94 1 to 2 Result Q | TUF SD-DUP2*II-1 2/23/94 1 to 2 Result Q | TUF SD-DUP3*II-1 2/23/94 1 to 2 Result Q | TUF SD-TUF-1E(1-2)*II-2 7/26/94 1 to 2 Result Q | TUF SD-TUF-5D(1-2)*II-2 7/26/94 1 to 2 Result Q | TUF SD-TUF-7D(1-2)*II-2 7/25/94 1 to 2 Result Q | TUF SD-TUF-8D(1-2)*II-2 7/25/94 1 to 2 Result Q | TUF SD-TUF1A(S)*II-1 2/22/94 1 to 2 Result Q | TUF SD-TUF1B(S)*II-1 2/22/94 1 to 2 Result Q | TUF SD-TUF1C(S)*II-1 2/22/94 1 to 2 Result Q | TUF SD-TUF2B(S)*II-1 3/1/94 1 to 2 Result Q | TUF SD-TUF2C(S)*II-1 3/1/94 1 to 2 Result Q | TUF SD-TUF3A(S)*II-1 2/23/94 1 to 2 Result Q |
|---|--|--|--|---|---|---|---|--|--|--|---|---|--|
| 6010S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7041S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S BARIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S BERYLLIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CADMIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CALCIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CHROMIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S COBALT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S COPPER | 119 J | 39.2 | 89.3 | 14.1 J | 12.5 J | 14 J | 267 J | 74.8 J | 15.3 | 9.8 | 38.5 | 96.2 | 45.7 |
| 6010S IRON | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S MAGNESIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S MANGANESE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S NICKEL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S POTASSIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S SILVER | NA | 0.8 U | 0.8 U | NA | NA | NA | NA | 0.7 U | 0.55 U | 0.55 U | 0.6 U | 0.65 U | 0.85 U |
| 6010S SODIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SNZZS TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S VANADIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S ZINC | 925 | 170 | 403 | 16.2 U | 15.15 U | 57.3 | 1540 | 155 J | 28.2 | 34.6 | 718 | 205 | 174 |
| 7060S ARSENIC | 4.9 | 8.6 | 8.3 | 6.4 | 2.9 | 4.4 | 3.5 | 2.4 | 1.5 | 1.6 | 10.6 J | 3.7 J | 7.5 |
| 7421S LEAD | NA | 144 | 134 J | NA | NA | NA | NA | 37.5 J | 13.2 | 13.2 | 50.1 J | 56.4 J | 159 |
| 7472S MERCURY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7740S SELENIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7841S THALLIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 9010S CYANIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 9030S SULFIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-12
CRANSTON SITE
UPPER FACILITY REACH
SHALLOW RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TUF SD-TUF3B(S)*II-1 2/23/94 1 to 2 Result Q | TUF SD-TUF3C(S)*II-1 2/23/94 1 to 2 Result Q | TUF SD-TUF4A(S)*II-1 2/23/94 1 to 2 Result Q | TUF SD-TUF4B(S)*II-1 2/24/94 1 to 2 Result Q | TUF SD-TUF4C(S)*II-1 2/24/94 1 to 2 Result Q | TUF SD-TUF5A(S)*II-1 2/24/94 1 to 2 Result Q | TUF SD-TUF5B(S)*II-1 2/24/94 1 to 2 Result Q | TUF SD-TUF5C(S)*II-1 2/24/94 1 to 2 Result Q | TUF SD-TUF6A(S)*II-1 2/25/94 1 to 2 Result Q | TUF SD-TUF6B(S)*II-1 2/25/94 1 to 2 Result Q | TUF SD-TUF6C(S)*II-1 2/25/94 1 to 2 Result Q | TUF SD-TUF7A(S)*II-1 2/25/94 1 to 2 Result Q | TUF SD-TUF7B(S)*II-1 2/25/94 1 to 2 Result Q |
|---|--|--|--|--|--|--|--|--|--|--|--|--|--|
| 6010S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7041S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S BARIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S BERYLLIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CADMIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CALCIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CHROMIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S COBALT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S COPPER | 14 | 15.3 | 84.4 | 0.0542 | 12.3 | 0.0037 | 0.0144 | 1.36 J | 103 J | 8.3 J | 2.9 J | 38.7 J | 13.7 J |
| 6010S IRON | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S MAGNESIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S MANGANESE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S NICKEL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S POTASSIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S SILVER | 0.6 U | 0.6 U | 0.8 U | 1.4 | 0.55 U | 0.7 U | 0.6 U | 1.15 U | 0.75 U | 0.6 U | 0.55 U | 0.6 U | 0.65 U |
| 6010S SODIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SNZZS TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S VANADIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S ZINC | 39.6 | 52 | 427 | 85.2 | 43.8 | 24.5 | 23.9 | 9630 | 334 | 22.8 | 17.3 | 66.1 | 32.7 |
| 7060S ARSENIC | 2 | 8.3 | 8.2 | 3.9 | 3 | 2.1 | 2.6 | 115 | 4.3 | 4.1 | 3.6 | 5.7 | 3.1 |
| 7421S LEAD | 13.6 J | 39.7 | 149 | 41.6 | 21.2 | 19.9 | 19.5 | 495 | 151 | 8.7 | 9.1 | 30 | 19.6 |
| 747ZS MERCURY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7740S SELENIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7841S THALLIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 9010S CYANIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 9030S SULFIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-12
CRANSTON SITE
UPPER FACILITY REACH
SHALLOW RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TUF SD-TUF7C(S)*II-1 2/25/94 1 to 2 | TUF SD-TUF8A(S)*II-1 2/26/94 1 to 2 | TUF SD-TUF8C(S)*II-1 2/26/94 1 to 2 | TUF SD-TUF9A(S)*II-1 2/28/94 1 to 2 | TUF SD-TUF9B(S)*II-1 2/28/94 1 to 2 | TUF SD-TUF9C(S)*II-1 2/28/94 1 to 2 | UPPER FACILITY REACH SUMMARY | | | | |
|---|--|--|--|--|--|--|------------------------------|---------------------|---|---------------------|---------------------|
| | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| 6010S ANTIMONY | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 7041S ANTIMONY | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S BARIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S BERYLLIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S CADMIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S CALCIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S CHROMIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S COBALT | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S COPPER | 221 J | 6.4 | 17.7 | 3.9 | 2.9 | 16.3 | 32 | 43.68 | 43.68 | 267.00 | 0.0037 |
| 6010S IRON | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S MAGNESIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S MANGANESE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S NICKEL | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S POTASSIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S SILVER | 0.75 U | 0.6 U | 0.6 U | 0.6 U | 0.55 U | 0.55 U | 1 | 1.40 | 0.69 | 1.40 | 1.40 |
| 6010S SODIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S TIN | NA | NA | NA | NA | NA | NA | 0 | | | | |
| SNZZS TIN | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S VANADIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S ZINC | 3540 | 16.9 U | 199 | 8.1 U | 15.05 U | 106 | 27 | 705.70 | 597.67 | 9630.00 | 17.30 |
| 7060S ARSENIC | 5.1 | 16.4 J | 1.9 J | 10.6 J | 12.6 J | 1.4 J | 32 | 8.76 | 8.76 | 115.00 | 1.40 |
| 7421S LEAD | 154 | 31.5 J | 8.8 J | 12.6 J | 4 J | 5.8 J | 27 | 68.22 | 68.22 | 495.00 | 4.00 |
| 7472S MERCURY | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 7740S SELENIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 7841S THALLIUM | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 9010S CYANIDE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 9030S SULFIDE | NA | NA | NA | NA | NA | NA | 0 | | | | |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-1.
CRANSTON SITE
UPPER FACILITY REACH
DEEP RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TUF SD-TUF-1E(2-4)*II-2 7/26/94 2 to 4 Result Q | TUF SD-TUF-5C(4-6)*II-2 7/26/94 4 to 6 Result Q | TUF SD-TUF-5D(2-4)*II-2 7/26/94 2 to 4 Result Q | TUF SD-TUF-5D(4-6)*II-2 7/26/94 4 to 6 Result Q | TUF SD-TUF-8D(2-4)*II-2 7/25/94 2 to 4 Result Q | TUF SD-TUF1A(D)*II-1 2/22/94 3 to 4 Result Q | TUF SD-TUF1B(D)*II-1 2/22/94 3 to 4 Result Q | TUF SD-TUF3A(D)*II-1 2/23/94 3 to 4 Result Q | TUF SD-TUF4A(D)*II-1 2/23/94 3 to 4 Result Q | TUF SD-TUF4C(D)*II-1 2/24/94 3 to 4 Result Q |
|--|---|---|---|---|---|--|--|--|--|--|
| VOLATILE ORGANICS | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S CHLOROBENZENE | 0.00305 U | 0.00315 U | 0.003 U | 0.0029 U | 13 J | 0.0034 U | 0.0032 U | 0.0028 U | 0.052 | 0.2 |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| AROMATICS | | | | | | | | | | |
| 8240S BENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ETHYLBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S M&P-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S NAPHTHALENE | 0.00305 U | 0.00315 U | 0.003 U | 0.01 | 0.027 J | 0.0034 U | 0.0032 U | 0.0028 U | 0.00445 U | 0.00415 U |
| 8240S O-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S TOLUENE | 0.00305 U | 0.00315 U | 0.003 U | 0.0029 U | 0.009 J | 0.0034 U | 0.0032 U | 0.0028 U | 0.00445 U | 0.00415 U |
| KETONES / ALDEHYDES | | | | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 2-HEXANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ACETONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | |
| PAHs | | | | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ACENAPHTHYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(G,H,I)PERYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S CHRYSENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S NAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENANTHRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHthalATES | | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 0.2 U | 0.11 J | 0.17 J | 0.034 J | 7.6 | 2.6 J | 0.21 U | 0.185 U | 0.295 U | 1.9 |
| 8270S BUTYLBENZYLPHthalATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-BUTYLPHthalATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-OCTYLPHthalATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIMETHYLPHthalATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HALOGENATED | | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-CHLOROANILINE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHENOLS | | | | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PENTACHLOROPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| OTHER | | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| FINGERPRINT COMPOUNDS | | | | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TINUVIN 328 | 0.2 U | 0.21 U | 0.2 U | 0.19 U | 0.275 U | 0.225 U | 0.21 U | 0.185 U | 0.295 U | 2.3 |
| PCBs | | | | | | | | | | |
| 8080S PCB-1221 | 0.041 U | 0.042 U | 0.0395 U | 0.039 U | 0.055 U | 0.0455 U | 0.0425 U | 0.0375 U | 0.06 U | 0.055 U |
| 8080S PCB-1232 | 0.02 U | 0.0205 U | 0.0195 U | 0.019 U | 0.0275 U | 0.0225 U | 0.021 U | 0.0185 U | 0.029 U | 0.0275 U |
| 8080S PCB-1242 | 0.02 U | 0.0205 U | 0.0195 U | 0.019 U | 0.0275 U | 0.0225 U | 0.021 U | 0.0185 U | 0.029 U | 0.0275 U |
| 8080S PCB-1248 | 0.02 U | 0.013 J | 0.02 | 0.16 | 2.8 J | 0.0225 U | 0.076 | 0.0185 U | 0.029 U | 0.27 |
| 8080S PCB-1254 | 0.02 U | 0.0205 U | 0.0195 U | 0.019 U | 0.0275 U | 0.049 | 0.021 U | 0.0185 U | 0.029 U | 0.1 J |
| 8080S PCB-1260 | 0.02 U | 0.0205 U | 0.0195 U | 0.019 U | 0.14 J | 0.0225 U | 0.021 U | 0.0185 U | 0.029 U | 0.0275 U |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S BETA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S DIELDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN I | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN II | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN SULFATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN ALDEHYDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S KEPONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | | |
| 8142S DISULFOTON | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8142S METHYL PARATHION | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HERBICIDES | | | | | | | | | | |
| 8152S 2,4-D | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8152S DINOSEB | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | | |
| 8270S DCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZOFURAN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TRCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS 1,2,3,4,6,7,8-HPCLDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS 1,2,3,4,6,7,8-HPCLDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS 1,2,3,4,7,8,9-HPCLDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS 1,2,3,4,7,8-HXCLDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS 1,2,3,6,7,8-HXCLDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS 2,3,7,8-TCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS HPCDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS HPCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS HXCLDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS OCDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS OCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS TCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
P - Estimated maximum.
NA - Not analyzed.

TABLE 4-1.
CRANSTON SITE
UPPER FACILITY REACH
DEEP RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TUF SD-TUF5B(D)*II-1 2/24/94 3 to 4 Result Q | TUF SD-TUF6C(D)*II-1 2/24/94 3 to 4 Result Q | TUF SD-TUF7A(D)*II-1 2/25/94 3 to 4 Result Q | TUF SD-TUF7C(D)*II-1 2/25/94 3 to 4 Result Q | TUF SD-TUF8C(D)*II-1 2/26/94 3 to 4 Result Q | TUF SD-TUF9A(D)*II-1 2/28/94 3 to 4 Result Q | UPPER FACILITY REACH SUMMARY | | | | |
|--|--|--|--|--|--|--|------------------------------|---------------------|---|---------------------|---------------------|
| | | | | | | | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| VOLATILE ORGANICS | | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S CHLOROBENZENE | 0.028 J | 13000 | 0.00285 U | 0.0028 U | 0.0031 U | 0.00285 U | 5 | 2600 | 813 | 13000 | 0.028 |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| AROMATICS | | | | | | | | | | | |
| 8240S BENZENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S ETHYLBENZENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S M&P-XYLENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S NAPHTHALENE | 0.005 U | 340 U | 0.00285 U | 0.0028 U | 0.0031 U | 0.00285 U | 2 | 0.0185 | 21.3 | 0.027 | 0.01 |
| 8240S O-XYLENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S TOLUENE | 0.016 J | 3500 | 0.00285 U | 0.0028 U | 0.0031 U | 0.00285 U | 3 | 1170 | 219 | 3500 | 0.009 |
| KETONES / ALDEHYDES | | | | | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S 2-HEXANONE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S ACETONE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | | |
| PAHs | | | | | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S ACENAPHTHYLENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S ANTHRACENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S BENZO(G,H,I)PERYLENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S CHRYSENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S FLUORANTHENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S FLUORENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S NAPHTHALENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S PHENANTHRENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S PYRENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| PHTHALATES | | | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 1.6 | 440 | 0.19 U | 0.058 J | 0.2 U | 0.19 U | 9 | 50.5 | 28.5 | 440 | 0.034 |
| 8270S BUTYLBENZYLPHTHALATE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DI-N-BUTYLPHTHALATE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DI-N-OCTYLPHTHALATE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DIMETHYLPHTHALATE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| HALOGENATED | | | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 4-CHLOROANILINE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| PHENOLS | | | | | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S PENTACHLOROPHENOL | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S PHENOL | NA | NA | NA | NA | NA | NA | 0 | | | | |
| OTHER | | | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| FINGERPRINT COMPOUNDS | | | | | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S TINUVIN 328 | 0.335 U | 890 | 0.19 U | 0.185 U | 0.2 U | 0.19 U | 2 | 446 | 56 | 890 | 2.3 |
| PCBs | | | | | | | | | | | |
| 8080S PCB-1221 | 0.07 U | 230 U | 0.0385 U | 0.0375 U | 0.0415 U | 0.0385 U | 0 | | | | |
| 8080S PCB-1232 | 0.0335 U | 115 U | 0.019 U | 0.0185 U | 0.0205 U | 0.019 U | 0 | | | | |
| 8080S PCB-1242 | 0.0335 U | 115 U | 0.019 U | 0.0185 U | 0.0205 U | 0.019 U | 0 | | | | |
| 8080S PCB-1248 | 0.0335 U | 5400 | 0.019 U | 0.0185 U | 0.0205 U | 0.019 U | 7 | 772 | 338 | 5400 | 0.013 |
| 8080S PCB-1254 | 0.14 | 115 U | 0.019 U | 0.0185 U | 0.0205 U | 0.019 U | 3 | 0.0963 | 7.22 | 0.14 | 0.049 |
| 8080S PCB-1260 | 0.16 | 115 U | 0.019 U | 0.0185 U | 0.0205 U | 0.019 U | 2 | 0.15 | 7.22 | 0.16 | 0.14 |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S 4,4'-DDE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S 4,4'-DDT | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ALDRIN | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ALPHA-BHC | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ALPHA-CHLORDANE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S BETA-BHC | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S DIELDRIN | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDOSULFAN I | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDOSULFAN II | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDOSULFAN SULFATE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDRIN | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDRIN ALDEHYDE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S GAMMA-BHC | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S GAMMA-CHLORDANE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S HEPTACHLOR | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S KEPONE | NA | NA | NA | NA | NA | NA | 0 | | | | |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | | | |
| 8142S DISULFOTON | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8142S METHYL PARATHION | NA | NA | NA | NA | NA | NA | 0 | | | | |
| HERBICIDES | | | | | | | | | | | |
| 8152S 2,4-D | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8162S DINOSEB | NA | NA | NA | NA | NA | NA | 0 | | | | |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | | | |
| 8270S DCDF | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DIBENZOFURAN | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S TRCDF | NA | NA | NA | NA | NA | NA | 0 | | | | |
| SOWZS 1,2,3,4,6,7,8-HPCDD | NA | NA | NA | 0.00003 U | 0.0045 | NA | 1 | 0.0045 | 0.00227 | 0.0045 | 0.0045 |
| SOWZS 1,2,3,4,6,7,8-HPCDF | NA | NA | NA | 0.000055 U | 0.00026 F | NA | 1 | 0.00026 | 0.000158 | 0.00026 | 0.00026 |
| SOWZS 1,2,3,4,7,8,9-HPCDF | NA | NA | NA | 0.000065 U | 0.000115 U | NA | 0 | | | | |
| SOWZS 1,2,3,4,7,8-HXCDF | NA | NA | NA | 0.00005 U | 0.00018 U | NA | 0 | | | | |
| SOWZS 1,2,3,6,7,8-HXCDF | NA | NA | NA | 0.0000425 U | 0.000135 U | NA | 0 | | | | |
| SOWZS 2,3,7,8-TCDF | NA | NA | NA | 0.000065 U | 0.00021 U | NA | 0 | | | | |
| SOWZS HPCDD | NA | NA | NA | 0.00003 U | 0.0076 | NA | 1 | 0.0076 | 0.00382 | 0.0076 | 0.0076 |
| SOWZS HPCDF | NA | NA | NA | 0.000055 U | 0.0008 J | NA | 1 | 0.0008 | 0.000428 | 0.0008 | 0.0008 |
| SOWZS HXCDF | NA | NA | NA | 0.0000425 U | 0.00042 J | NA | 1 | 0.00042 | 0.000231 | 0.00042 | 0.00042 |
| SOWZS OCDD | NA | NA | NA | 0.000115 U | 0.038 | NA | 1 | 0.038 | 0.0191 | 0.038 | 0.038 |
| SOWZS OCDF | NA | NA | NA | 0.00008 U | 0.00038 J | NA | 1 | 0.00038 | 0.00023 | 0.00038 | 0.00038 |
| SOWZS TCDF | NA | NA | NA | 0.000065 U | 0.00021 U | NA | 0 | | | | |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-14
CRANSTON SITE
UPPER FACILITY REACH
DEEP RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TUF SD-TUF-1E(2-4)*II-2 7/26/94 2 to 4 Result Q | TUF SD-TUF-5C(4-6)*II-2 7/26/94 4 to 6 Result Q | TUF SD-TUF-5D(2-4)*II-2 7/26/94 2 to 4 Result Q | TUF SD-TUF-5D(4-6)*II-2 7/26/94 4 to 6 Result Q | TUF SD-TUF-8D(2-4)*II-2 7/25/94 2 to 4 Result Q | TUF SD-TUF1A(D)*II-1 2/22/94 3 to 4 Result Q | TUF SD-TUF1B(D)*II-1 2/22/94 3 to 4 Result Q | TUF SD-TUF3A(D)*II-1 2/23/94 3 to 4 Result Q | TUF SD-TUF4A(D)*II-1 2/23/94 3 to 4 Result Q | TUF SD-TUF4C(D)*II-1 2/24/94 3 to 4 Result Q | TUF SD-TUF5B(D)*II-1 2/24/94 3 to 4 Result Q |
|---|---|---|---|---|---|--|--|--|--|--|--|
| 6010S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7041S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S BARIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S BERYLLIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CADMIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CALCIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CHROMIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S COBALT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S COPPER | 16.6 J | 9.6 J | 9.1 J | 3.8 J | 77.9 J | 64.4 | 11.6 | 3.2 | 2.2 U | 84.9 | 184 J |
| 6010S IRON | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S MAGNESIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S MANGANESE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S NICKEL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S POTASSIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S SILVER | NA | NA | NA | NA | NA | 0.7 U | 0.65 U | 0.55 U | 0.9 U | 0.85 U | 1 U |
| 6010S SODIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SNZZS TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S VANADIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S ZINC | 40.6 | 7.9 U | 13.45 U | 6.25 U | 1610 | 114 | 38.5 | 12.4 | 37.8 | 180 | 612 |
| 7060S ARSENIC | 5.4 | 3.2 | 5.1 | 4.5 | 8.6 | 4.4 | 1.4 | 2.6 | 0.9 U | 21.4 | 9.7 |
| 7421S LEAD | NA | NA | NA | NA | NA | 63 | 10.9 | 11 | 3.5 | 143 | 272 |
| 7472S MERCURY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7740S SELENIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7841S THALLIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 9010S CYANIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 9030S SULFIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-14
CRANSTON SITE
UPPER FACILITY REACH
DEEP RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TUF SD-TUF5C(D)*II-1 2/24/94 3 to 4 | TUF SD-TUF7A(D)*II-1 2/25/94 3 to 4 | TUF SD-TUF7C(D)*II-1 2/25/94 3 to 4 | TUF SD-TUF8C(D)*II-1 2/26/94 3 to 4 | TUF SD-TUF9A(D)*II-1 2/28/94 3 to 4 | UPPER FACILITY REACH SUMMARY | | | | |
|---|--|--|--|--|--|------------------------------|---------------------|---|---------------------|---------------------|
| | Result Q | Result Q | Result Q | Result Q | Result Q | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| | | | | | | | | | | |
| 6010S ANTIMONY | NA | NA | NA | NA | NA | 0 | | | | |
| 7041S ANTIMONY | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S BARIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S BERYLLIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S CADMIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S CALCIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S CHROMIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S COBALT | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S COPPER | 0.257 J | 2.9 J | 1.4 U | 10.7 | 4.2 | 14 | 34.5 | 30.4 | 184.00 | 0.26 |
| 6010S IRON | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S MAGNESIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S MANGANESE | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S NICKEL | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S POTASSIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S SILVER | 0.7 U | 0.6 U | 0.55 U | 0.6 U | 0.6 U | 0 | | 0.7 | | |
| 6010S SODIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S TIN | NA | NA | NA | NA | NA | 0 | | | | |
| SNZZS TIN | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S VANADIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S ZINC | 131 | 30.3 | 20.9 | 13.95 U | 9.05 U | 11 | 257 | 180 | 1610.00 | 12.40 |
| 7060S ARSENIC | 9 | 37.3 | 2.6 | 2 J | 45.2 J | 15 | 10.8 | 10.2 | 45.20 | 1.40 |
| 7421S LEAD | 48.1 | 2.6 | 1.3 | 6.3 J | 1.7 J | 11 | 51.2 | 51.2 | 272.00 | 1.30 |
| 747ZS MERCURY | NA | NA | NA | NA | NA | 0 | | | | |
| 7740S SELENIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 7841S THALLIUM | NA | NA | NA | NA | NA | 0 | | | | |
| 9010S CYANIDE | NA | NA | NA | NA | NA | 0 | | | | |
| 9030S SULFIDE | NA | NA | NA | NA | NA | 0 | | | | |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-15
CRANSTON SITE
LOWER FACILITY REACH
RIVER SEDIMENT
ORGANIC DATA

| REACH | TLF | TLF | TLF | TLF | TLF | TLF | TLF | TLF | TLF | TLF | TLF |
|----------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|----------------------|----------|
| SAMPLE ID | SD-04R*IB-2 | SD-05L*IB-1 | SD-06M*IB-2 | SD-06R*IB-1 | SD-07L*IB-1 | SD-07L*IB-2 | SD-08M*IB-1 | SD-08M*IB-2 | SD-DUP1*IB-1 | SD-TLF-12C(1-2)*IB-2 | |
| COLLECT DATE | 3/27/91 | 11/29/90 | 3/28/91 | 11/29/90 | 11/29/90 | 3/28/91 | 11/29/90 | 3/27/91 | 2/16/94 | 7/27/94 | |
| DEPTH RANGE (FT) | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 1 to 2 | |
| Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q |
| VOLATILE ORGANICS | | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | 0.075 U | 0.065 U | 0.065 U | 0.085 U | 0.075 U | 0.34 J | 0.06 U | 0.068 U | NA | NA | |
| 8240S CHLOROBENZENE | 0.17 | 0.065 U | 0.065 U | 0.085 U | 0.075 U | 0.145 U | 0.06 U | 0.065 U | 0.13 J | 0.0029 U | |
| 8240S TRANS-1,2-DICHLOROETHENE | 0.075 U | 0.065 U | 0.065 U | 0.085 U | 0.075 U | 0.145 U | 0.06 U | 0.065 U | NA | NA | |
| AROMATICS | | | | | | | | | | | |
| 8240S BENZENE | 0.075 U | 0.065 U | 0.065 U | 0.085 U | 0.075 U | 0.145 U | 0.06 U | 0.065 U | NA | NA | |
| 8240S ETHYLBENZENE | 0.075 U | 0.065 U | 0.065 U | 0.085 U | 0.075 U | 0.145 U | 0.06 U | 0.065 U | NA | NA | |
| 8240S M&P-XYLENE | 0.075 U | 0.065 U | 0.065 U | 0.085 U | 0.075 U | 0.145 U | 0.06 U | 0.065 U | NA | NA | |
| 8240S NAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | 0.0044 U | 0.0029 U | |
| 8240S O-XYLENE | 0.075 U | 0.065 U | 0.065 U | 0.085 U | 0.075 U | 0.145 U | 0.06 U | 0.065 U | NA | NA | |
| 8240S TOLUENE | 0.58 | 0.035 J | 0.19 | R | 0.075 U | 0.145 U | 0.06 U | 0.065 U | 0.0044 U | 0.0029 U | |
| KETONES / ALDEHYDES | | | | | | | | | | | |
| 8240S 2-BUTANONE | 0.15 U | 0.125 U | 0.125 U | 0.165 U | 0.15 U | 0.33 J | 0.12 U | 0.125 U | NA | NA | |
| 8240S 2-HEXANONE | 0.15 U | 0.125 U | 0.125 U | 0.165 U | 0.15 U | 0.295 U | 0.12 U | 0.125 U | NA | NA | |
| 8240S 4-METHYL-2-PENTANONE | 0.15 U | 0.125 U | 0.125 U | 0.165 U | 0.15 U | 0.295 U | 0.12 U | 0.125 U | NA | NA | |
| 8240S ACETONE | 0.15 U | 0.125 U | 0.125 U | 0.165 U | 0.15 U | 0.295 U | 0.12 U | 0.125 U | NA | NA | |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | | |
| PAHs | | | | | | | | | | | |
| 8270S ACENAPHTHENE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.049 J | 0.13 J | 0.6 U | 0.6 U | NA | NA | |
| 8270S ACENAPHTHYLENE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| 8270S ANTHRACENE | 0.14 J | 0.048 J | 0.07 J | 0.085 J | 0.15 J | 0.33 J | 0.065 J | 0.14 J | NA | NA | |
| 8270S BENZO(A)ANTHRACENE | 0.8 J | 0.32 J | 0.32 J | 0.96 J | 0.76 J | 2.1 J | 0.28 J | 0.42 J | NA | NA | |
| 8270S BENZO(A)PYRENE | 0.85 J | 0.6 U | 0.27 J | 0.79 J | 0.69 J | 2.2 J | 0.6 U | 0.35 J | NA | NA | |
| 8270S BENZO(B)FLUORANTHENE | 1.4 | 0.53 J | 0.54 J | 2.1 | 1.5 | 4.6 | 0.47 J | 0.32 J | NA | NA | |
| 8270S BENZO(G,H)PERYLENE | 0.84 J | 0.8 U | 0.3 J | 0.8 U | 0.83 J | 2.2 J | 0.6 U | 0.32 J | NA | NA | |
| 8270S BENZO(K)FLUORANTHENE | 1.6 | 0.55 J | 0.61 J | 2.2 | 1.6 | 5.1 | 0.49 J | 0.36 J | NA | NA | |
| 8270S CHRYSENE | 1.1 J | 0.37 J | 0.39 J | 1.1 J | 1.1 J | 3.4 | 0.4 J | 0.44 J | NA | NA | |
| 8270S DIBENZO(A,H)ANTHRACENE | 0.14 J | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 0.34 J | 0.6 U | 0.6 U | NA | NA | |
| 8270S FLUORANTHENE | 3.1 | 0.6 J | 1 J | 1.6 | 1.8 | 8.2 | 0.64 J | 1.2 | NA | NA | |
| 8270S FLUORENE | 0.089 J | 0.6 U | 0.6 U | 0.8 U | 0.78 J | 0.22 J | 0.035 J | 0.063 J | NA | NA | |
| 8270S INDENO(1,2,3-CD)PYRENE | 0.7 J | 0.6 U | 0.24 J | 1 J | 0.9 J | 2 J | 0.6 U | 0.28 J | NA | NA | |
| 8270S 2-METHYLNAPHTHALENE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| 8270S NAPHTHALENE | 0.17 J | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 0.21 J | 0.6 U | 0.6 U | NA | NA | |
| 8270S PHENANTHRENE | 1 J | 0.28 J | 0.44 J | 0.84 J | 0.89 J | 2.2 J | 0.45 J | 0.61 J | NA | NA | |
| 8270S PYRENE | 1 J | 0.67 J | 0.4 J | 1.7 | 1.8 | 2.6 J | 0.71 J | 0.43 J | NA | NA | |
| PHTHALATES | | | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 0.7 U | 0.3 J | 0.6 U | 0.8 U | 5 | 1.45 U | 0.81 J | 0.6 U | 0.59 J | 0.1 J | |
| 8270S BUTYLBENZYLPHthalATE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.22 J | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| 8270S DI-N-BUTYLPHthalATE | 0.7 U | 0.023 J | 0.037 J | 0.8 U | 0.038 J | 1.45 U | 0.6 U | 0.044 J | NA | NA | |
| 8270S DI-N-OCTYLPHthalATE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| 8270S DIMETHYLPHthalATE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | R | 0.6 U | NA | NA | |
| HALOGENATED | | | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| 8270S 1,2-DICHLOROBENZENE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 0.2 J | 0.6 U | 0.6 U | NA | NA | |
| 8270S 1,3-DICHLOROBENZENE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| 8270S 1,4-DICHLOROBENZENE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 0.21 J | 0.6 U | 0.6 U | NA | NA | |
| 8270S 4-CHLOROANILINE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| PHENOLS | | | | | | | | | | | |
| 8270S 2-METHYLPHENOL | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | |
| 8270S 4-METHYLPHENOL | 0.14 J | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| 8270S PENTACHLOROPHENOL | 3.6 U | 3.05 U | 3.05 U | 4.1 U | 3.8 U | 7 U | 3.05 U | 3.05 U | NA | NA | |
| 8270S PHENOL | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| OTHER | | | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | 0.7 U | 0.6 U | 0.6 U | 0.8 U | 0.75 U | 1.45 U | 0.6 U | 0.6 U | NA | NA | |
| FINGERPRINT COMPOUNDS | | | | | | | | | | | |
| 8270S TINUVIN 327 | 3.6 U | 0.23 J | 3.05 U | 4.1 U | 0.23 J | 7 U | 3.05 U | 3.05 U | NA | NA | |
| 8270S TINUVIN 328 | NA | NA | NA | NA | NA | NA | NA | NA | 0.19 J | 0.19 U | |
| PCBs | | | | | | | | | | | |
| 8080S PCB-1221 | 0.15 U | 0.06 U | 0.0125 U | 0.32 U | 0.15 U | 0.0285 U | 0.06 U | 0.0125 U | 0.06 U | 0.038 U | |
| 8080S PCB-1232 | 0.15 U | 0.06 U | 0.0125 U | 0.32 U | 0.15 U | 0.0285 U | 0.06 U | 0.0125 U | 0.029 U | 0.019 U | |
| 8080S PCB-1242 | 0.075 U | 0.03 U | 0.0065 U | 0.16 U | 0.075 U | 0.014 U | 0.0295 U | 0.0065 U | 0.029 U | 0.019 U | |
| 8080S PCB-1248 | 0.075 U | 0.03 U | 0.0065 U | 0.16 U | 0.075 U | 0.014 U | 0.0295 U | 0.0065 U | 0.029 U | 0.11 | |
| 8080S PCB-1254 | 0.15 U | 0.06 U | 0.0125 U | 0.32 U | 0.15 U | 0.0285 U | 0.06 U | 0.0125 U | 0.046 J | 0.019 U | |
| 8080S PCB-1260 | 0.15 U | 0.06 U | 0.0125 U | 0.32 U | 0.15 U | 0.0285 U | 0.06 U | 0.0125 U | 0.029 U | 0.017 J | |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | | |
| 8080S 4,4'-DDD | 0.0075 U | 0.003 U | 0.00065 U | 0.016 U | 0.0075 U | 0.0014 U | 0.00295 U | 0.00065 U | NA | NA | |
| 8080S 4,4'-DDE | 0.0075 U | 0.003 U | 0.00065 U | 0.016 U | 0.0075 U | 0.06 J | 0.00295 U | 0.00065 U | NA | NA | |
| 8080S 4,4'-DDT | 0.013 J | 0.006 U | 0.00125 U | 0.032 U | 0.016 U | 0.012 J | 0.006 U | 0.0012 J | NA | NA | |
| 8080S ALDRIN | 0.035 | 0.003 U | 0.0051 | 0.016 U | 0.0075 U | 0.025 J | 0.00295 U | 0.00065 U | NA | NA | |
| 8080S ALPHA-BHC | 0.0075 U | 0.003 U | 0.00065 U | 0.026 J | 0.0075 U | 0.0014 U | 0.00295 U | 0.00065 U | NA | NA | |
| 8080S ALPHA-CHLORDANE | 0.0075 U | 0.003 U | 0.00065 U | 0.016 U | 0.0075 U | 0.0014 U | 0.00295 U | 0.00065 U | NA | NA | |
| 8080S BETA-BHC | 0.0075 U | 0.003 U | 0.00065 U | 0.016 U | 0.0075 U | 0.0014 U | 0.00295 U | 0.00065 U | NA | NA | |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | |
| 8080S DIELDRIN | 0.062 | 0.0053 J | 0.00065 U | 0.023 J | 0.0075 U | 0.0014 U | 0.0051 J | 0.00065 U | NA | NA | |
| 8080S ENDOSULFAN I | 0.0075 U | 0.003 U | 0.00065 U | 0.016 U | 0.0075 U | 0.0014 U | 0.00295 U | 0.00065 U | NA | NA | |
| 8080S ENDOSULFAN II | 0.0225 U | 0.009 U | 0.0019 U | 0.0015 J | 0.0225 U | 0.00425 U | 0.009 U | 0.0019 U | NA | NA | |
| 8080S ENDOSULFAN SULFATE | 0.0375 U | 0.015 U | 0.0032 U | 0.08 U | 0.037 U | 0.007 U | 0.0145 U | 0.00315 U | NA | NA | |
| 8080S ENDRIN | 0.0075 U | 0.003 U | 0.00065 U | 0.016 U | 0.0075 U | 0.01 J | 0.00295 U | 0.00065 U | NA | NA | |
| 8080S ENDRIN ALDEHYDE | 0.015 U | 0.006 U | 0.0017 U | 0.032 U | 0.015 U | 0.00285 U | 0.006 U | 0.00125 U | NA | NA | |
| 8080S GAMMA-BHC | 0.0075 U | 0.003 U | 0.0033 | 0.016 U | 0.0075 U | 0.021 J | 0.00295 U | 0.00065 U | NA | NA | |
| 8080S GAMMA-CHLORDANE | 0.0075 U | 0.003 U | 0.00065 U | 0.019 J | 0.0075 U | 0.054 J | 0.0073 | 0.00065 U | NA | NA | |
| 8080S HEPTACHLOR | 0.044 | 0.003 U | 0.002 | 0.016 U | 0.0075 U | 0.014 J | 0.00485 U | 0.00065 U | NA | NA | |
| 8080S HEPTACHLOR EPOXIDE | 0.078 | 0.003 U | 0.00065 U | 0.016 U | 0.0075 U | 0.0014 U | 0.00295 U | 0.00065 U | NA | NA | |
| 8080S KEPONE | 0.0075 U | 0.003 U | 0.00065 U | 0.016 U | 0.0075 U | 0.0014 U | 0.00295 U | 0.00065 U | NA | NA | |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | | | |
| 8142S DISULFOTON | 0.075 U | 0.0027 J | 0.06 U | 0.165 U | 0.12 J | 0.037 J | 0.06 U | 0.06 U | NA | NA | |
| 8142S METHYL PARATHION | 0.011 U | 0.0046 J | 0.009 U | 0.044 J | R | 0.022 U | 0.0024 J | 0.009 U | NA | NA | |
| HERBICIDES | | | | | | | | | | | |
| 8162S 2,4-D | 0.085 U | 0.07 U | 0.075 U | 0.09 U | 0.024 J | 0.165 U | 0.075 U | 0.075 U | NA | | |

TABLE 4-15
CRANSTON SITE
LOWER FACILITY REACH
RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TLF SD-TLF-12C(2-4)*II-2 7/27/94 2 to 4 Result Q | TLF SD-TLF10A*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF10B*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF11A*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF11B*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF12A*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF12B*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF1A*II-1 2/18/94 0 to .5 Result Q | TLF SD-TLF1B*II-1 2/18/94 0 to .5 Result Q | TLF SD-TLF2A*II-1 2/18/94 0 to .5 Result Q |
|--|--|---|---|---|---|---|---|--|--|--|
| VOLATILE ORGANICS | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S CHLOROBENZENE | 0.0033 U | 0.003 U | 0.0028 U | 0.0043 U | 0.003 U | 0.0066 | 0.13 J | 0.00345 U | 0.0027 U | 0.00275 U |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| AROMATICS | | | | | | | | | | |
| 8240S BENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ETHYLBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S M&P-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S NAPHTHALENE | 0.0033 U | 0.003 U | 0.0028 U | 0.0043 U | 0.003 U | 0.0031 U | 0.015 J | 0.00345 U | 0.0027 U | 0.00275 U |
| 8240S O-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S TOLUENE | 0.0033 U | 0.003 U | 0.0028 U | 0.0043 U | 0.003 U | 0.0031 U | 0.0031 U | 0.00345 U | 0.0027 U | 0.00275 U |
| KETONES / ALDEHYDES | | | | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 2-HEXANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ACETONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | |
| PAHs | | | | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ACENAPHTHYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(G,H,I)PERYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S CHRYSENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZO(A,I)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S NAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENANTHRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHTHALATES | | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 0.49 | 1.2 | 5.2 | 18 | 0.76 | 90 J | 4.4 | 2.4 | 0.176 U | 0.18 U |
| 8270S BUTYLBENZYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-BUTYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-OCTYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIMETHYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HALOGENATED | | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-CHLOROANILINE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHENOLS | | | | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PENTACHLOROPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| OTHER | | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| FINGERPRINT COMPOUNDS | | | | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TINUVIN 328 | 0.215 U | 0.23 J | 5.7 J | 2.5 | 0.26 J | 0.161 J | 1.5 | 0.33 U | 11 | 0.18 U |
| PCBs | | | | | | | | | | |
| 8080S PCB-1221 | 0.0435 U | 0.2 U | 0.075 U | 0.06 U | 0.04 U | 0.0415 U | 0.205 U | 0.0485 U | 0.039 U | 0.037 U |
| 8080S PCB-1223 | 0.0215 U | 0.1 U | 0.4 | 0.0285 U | 0.0195 U | 0.0205 U | 0.1 U | 0.023 U | 0.039 U | 0.018 U |
| 8080S PCB-1242 | 0.0215 U | 0.1 U | 0.0365 U | 0.0285 U | 0.0195 U | 0.0205 U | 0.1 U | 0.023 U | 0.039 U | 0.018 U |
| 8080S PCB-1248 | 0.15 | 0.1 U | 0.0365 U | 0.21 | 0.052 | 0.1 J | 1.1 | 0.023 U | 0.039 U | 0.017 J |
| 8080S PCB-1254 | 0.0215 U | 0.71 | 0.19 J | 0.13 J | 0.049 | 0.13 J | 1.3 | 0.085 | 0.076 J | 0.018 U |
| 8080S PCB-1260 | 0.0215 U | 0.1 U | 0.0365 U | 0.087 J | 0.0195 U | 0.0205 U | 0.1 U | 0.023 U | 0.019 U | 0.018 U |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S BETA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S DIELDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN I | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN II | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN SULFATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN ALDEHYDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S KEPONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | | |
| 8142S DISULFOTON | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8142S METHYL PARATHION | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HERBICIDES | | | | | | | | | | |
| 8152S 2,4-D | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8152S DINOSEB | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | | |
| 8270S DCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZOFURAN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TRCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOW2S 1,2,3,4,6,7,8-HPCDD | NA | NA | 0.000046 U | 0.00008 U | NA | NA | 0.000066 F | 0.000115 U | NA | 0.000055 U |
| SOW2S 1,2,3,4,6,7,8-HPCDF | NA | NA | 0.00008 U | 0.000065 U | NA | NA | 0.000065 U | 0.00022 U | NA | 0.000085 U |
| SOW2S 1,2,3,4,7,8,9-HPCDF | NA | NA | 0.000095 U | 0.000075 U | NA | NA | 0.000075 U | 0.00023 U | NA | 0.00009 U |
| SOW2S 1,2,3,4,7,8-HXCDF | NA | NA | 0.00012 U | 0.000125 U | NA | NA | 0.000175 U | 0.000185 U | NA | 0.000055 U |
| SOW2S 1,2,3,6,7,8-HXCDF | NA | NA | 0.000095 U | 0.0001 U | NA | NA | 0.00014 U | 0.000165 U | NA | 0.00005 U |
| SOW2S 2,3,7,8-TCDF | NA | NA | 0.000105 U | 0.00009 U | NA | NA | 0.00013 U | 0.00011 U | NA | 0.000055 U |
| SOW2S HPCDD | NA | NA | 0.000046 U | 0.00008 U | NA | NA | 0.000066 F | 0.000115 U | NA | 0.000055 U |
| SOW2S HPCDF | NA | NA | 0.00008 U | 0.000065 U | NA | NA | 0.000065 U | 0.00022 U | NA | 0.000085 U |
| SOW2S HXCDF | NA | NA | 0.000095 U | 0.0001 U | NA | NA | 0.00014 U | 0.000165 U | NA | 0.00005 U |
| SOW2S OCDD | NA | NA | 0.000255 U | 0.00049 J | NA | NA | 0.00065 J | 0.00077 J | NA | 0.000155 U |
| SOW2S OCDF | NA | NA | 0.000115 U | 0.00017 U | NA | NA | 0.000095 U | 0.0002 F | NA | 0.00019 U |
| SOW2S TCDF | NA | NA | 0.000105 U | 0.00009 U | NA | NA | 0.00013 U | 0.00011 U | NA | 0.000095 U |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-15
CRANSTON SITE
LOWER FACILITY REACH
RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TLF SD-TLF2B*II-1 2/18/94 0 to .5 | TLF SD-TLF3A*II-1 2/18/94 0 to .5 | TLF SD-TLF3B*II-1 2/18/94 0 to .5 | TLF SD-TLF4A*II-1 2/17/94 0 to .5 | TLF SD-TLF4B*II-1 2/17/94 0 to .5 | TLF SD-TLF6A*II-1 2/17/94 0 to .5 | TLF SD-TLF6B*II-1 2/17/94 0 to .5 | TLF SD-TLF6A*II-1 2/17/94 0 to .5 | TLF SD-TLF6B*II-1 2/17/94 0 to .5 | TLF SD-TLF7A*II-1 2/17/94 0 to .5 |
|--|--|--|--|--|--|--|--|--|--|--|
| | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q |
| VOLATILE ORGANICS | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S CHLOROBENZENE | 0.0028 U | 0.00285 U | 0.00395 U | 0.0079 | 0.26 | 0.0043 U | 0.00295 U | 0.003 U | 0.071 J | 0.0031 U |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| AROMATICS | | | | | | | | | | |
| 8240S BENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ETHYLBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S M&P-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S NAPHTHALENE | 0.0028 U | 0.00285 U | 0.00395 U | 0.00385 U | 0.012 J | 0.0043 U | 0.00295 U | 0.003 U | 0.041 J | 0.0031 U |
| 8240S O-XYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S TOLUENE | 0.0028 U | 0.00285 U | 0.00395 U | 0.00385 U | 0.0065 J | 0.0043 U | 0.00295 U | 0.003 U | 0.018 J | 0.0031 U |
| KETONES / ALDEHYDES | | | | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 2-HEXANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8240S ACETONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | |
| PAHs | | | | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ACENAPHTHYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(A)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(G,H,I)PERYLENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S CHRYSENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORANTHENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S FLUORENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S NAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENANTHRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PYRENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHTHALATES | | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 0.185 U | 0.19 U | 0.26 U | 4 J | 0.205 U | 8.5 | 0.195 U | 9.4 J | 2.4 | R |
| 8270S BUTYLBENZYL PHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-BUTYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DI-N-OCTYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIMETHYLPHTHALATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HALOGENATED | | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-CHLOROANILINE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| PHENOLS | | | | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PENTACHLOROPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S PHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| OTHER | | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| FINGERPRINT COMPOUNDS | | | | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TINUVIN 328 | 18 J | 0.19 U | 0.26 U | 2.3 J | 3.6 J | 4.2 | 0.195 U | 22 J | 27 | R |
| PCBs | | | | | | | | | | |
| 8080S PCB-1221 | 0.037 U | 0.038 U | 0.056 U | 0.05 U | 0.26 J | 0.06 U | 0.0395 U | 0.06 U | 7.9 J | 0.041 U |
| 8080S PCB-1232 | 0.053 | 0.019 U | 0.076 | 0.025 U | 0.0205 U | 0.0285 U | 0.0195 U | 0.0285 U | 0.02 U | 0.02 U |
| 8080S PCB-1242 | 0.0185 U | 0.019 U | 0.026 U | 0.025 U | 0.0205 U | 0.0285 U | 0.0195 U | 0.0285 U | 0.02 U | 0.02 U |
| 8080S PCB-1248 | 0.0185 U | 0.019 U | 0.026 U | 0.025 U | 0.38 J | 0.0285 U | 0.0195 U | 0.0285 U | 2.2 J | 0.1 J |
| 8080S PCB-1254 | 0.058 | 0.019 U | 0.21 | 0.094 | 0.0205 U | 0.14 | 0.0195 U | 0.22 | 1.4 J | 0.02 U |
| 8080S PCB-1260 | 0.0185 U | 0.019 U | 0.026 U | 0.053 J | 0.0205 U | 0.065 | 0.0195 U | 0.0285 U | 0.02 U | 0.02 U |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ALPHA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S BETA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S DIELDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN I | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN II | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN SULFATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S ENDRIN ALDEHYDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-BHC | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S GAMMA-CHLORDANE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S KEPONE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | | |
| 8142S DISULFOTON | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8142S METHYL PARATHION | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HERBICIDES | | | | | | | | | | |
| 8152S 2,4-D | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8152S DINOSEB | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | | |
| 8270S DCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S DIBENZOFURAN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S TCDF | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SOWZS 1,2,3,4,6,7,8-HPCLDD | NA | 0.000055 U | NA | NA | 0.000047 U | NA | 0.00006 U | 0.000025 U | NA | 0.000095 U |
| SOWZS 1,2,3,4,6,7,8-HPCLDF | NA | 0.00006 U | NA | NA | 0.00004 U | NA | 0.00007 U | 0.000055 U | NA | 0.00007 U |
| SOWZS 1,2,3,4,7,8,9-HPCLDF | NA | 0.000075 U | NA | NA | 0.000048 U | NA | 0.00008 U | 0.00009 U | NA | 0.00008 U |
| SOWZS 1,2,3,4,7,8-HXCLDF | NA | 0.00006 U | NA | NA | 0.000039 U | NA | 0.000085 U | 0.000034 U | NA | 0.00005 U |
| SOWZS 1,2,3,6,7,8-HXCLDF | NA | 0.000048 U | NA | NA | 0.000032 U | NA | 0.00007 U | 0.0000315 U | NA | 0.0000485 U |
| SOWZS 2,3,7,8-TCDF | NA | 0.000085 U | NA | NA | 0.00009 U | NA | 0.000135 U | 0.0000455 U | NA | 0.000085 U |
| SOWZS HPCDD | NA | 0.000055 U | NA | NA | 0.000047 U | NA | 0.00006 U | 0.000025 U | NA | 0.000095 U |
| SOWZS HPCDF | NA | 0.00006 U | NA | NA | 0.00004 U | NA | 0.00007 U | 0.000055 U | NA | 0.00007 U |
| SOWZS HXCLDF | NA | 0.000048 U | NA | NA | 0.000032 U | NA | 0.00007 U | 0.0000315 U | NA | 0.0000485 U |
| SOWZS OCDD | NA | 0.00009 U | NA | NA | 0.00048 J | NA | 0.00023 U | 0.000085 U | NA | 0.0004 F |
| SOWZS OCDF | NA | 0.000095 U | NA | NA | 0.00007 U | NA | 0.00011 U | 0.00006 U | NA | 0.00009 U |
| SOWZS TCDF | NA | 0.000085 U | NA | NA | 0.00009 U | NA | 0.000135 U | 0.0000455 U | NA | 0.000085 U |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-15
CRANSTON SITE
LOWER FACILITY REACH
RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECT DATE DEPTH RANGE (FT) | TLF | TLF | TLF | TLF | TLF | LOWER FACILITY REACH SUMMARY | | | | |
|--|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|------------------------------|---------------------|---|---------------------|---------------------|
| | SD-TLF7B*II-1 2/17/94 0 to .5 | SD-TLF8A*II-1 2/17/94 0 to .5 | SD-TLF8B*II-1 2/17/94 0 to .5 | SD-TLF9A*II-1 2/16/94 0 to .5 | SD-TLF9B*II-1 2/16/94 0 to .5 | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| | Result Q | Result Q | Result Q | Result Q | Result Q | | | | | |
| VOLATILE ORGANICS | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | NA | NA | 1 | 0.34 | 0.104 | 0.34 | 0.34 |
| 8240S CHLOROBENZENE | 0.0029 U | 0.0031 U | 0.0029 U | 0.021 J | 0.00288 U | 8 | 0.0996 | 0.0406 | 0.26 | 0.0066 |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | NA | NA | NA | 0 | | | | |
| AROMATICS | | | | | | | | | | |
| 8240S BENZENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S ETHYLBENZENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S M&P-XYLENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S NAPHTHALENE | 0.0029 U | 0.0031 U | 0.0029 U | 0.00346 U | 0.00285 U | 3 | 0.0227 | 0.0054 | 0.041 | 0.012 |
| 8240S O-XYLENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S TOLUENE | 0.0029 U | 0.0031 U | 0.0029 U | 0.00346 U | 0.00285 U | 5 | 0.166 | 0.0369 | 0.58 | 0.0063 |
| KETONES / ALDEHYDES | | | | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | NA | NA | NA | 1 | 0.33 | 0.161 | 0.33 | 0.33 |
| 8240S 2-HEXANONE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | NA | NA | NA | 0 | | | | |
| 8240S ACETONE | NA | NA | NA | NA | NA | 0 | | | | |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | |
| PAHs | | | | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | NA | NA | NA | 2 | 0.0895 | 0.51 | 0.13 | 0.049 |
| 8270S ACENAPHTHYLENE | NA | NA | NA | NA | NA | 1 | 0.05 | 0.694 | 0.05 | 0.05 |
| 8270S ANTHRACENE | NA | NA | NA | NA | NA | 8 | 0.129 | 0.129 | 0.33 | 0.048 |
| 8270S BENZO(A)ANTHRACENE | NA | NA | NA | NA | NA | 8 | 0.745 | 0.745 | 2.1 | 0.28 |
| 8270S BENZO(A)PYRENE | NA | NA | NA | NA | NA | 8 | 0.858 | 0.794 | 2.2 | 0.27 |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | NA | NA | NA | 8 | 1.43 | 1.43 | 4.6 | 0.32 |
| 8270S BENZO(G,H,I)PERYLENE | NA | NA | NA | NA | NA | 5 | 0.898 | 0.811 | 2.2 | 0.3 |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | NA | NA | NA | 8 | 1.56 | 1.56 | 5.1 | 0.36 |
| 8270S CHRYSENE | NA | NA | NA | NA | NA | 8 | 1.04 | 1.04 | 3.4 | 0.37 |
| 8270S DIBENZO(A,H)ANTHRACENE | NA | NA | NA | NA | NA | 2 | 0.24 | 0.554 | 0.34 | 0.14 |
| 8270S FLUORANTHENE | NA | NA | NA | NA | NA | 8 | 2.27 | 2.27 | 8.2 | 0.6 |
| 8270S FLUORENE | NA | NA | NA | NA | NA | 5 | 0.097 | 0.311 | 0.22 | 0.035 |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | NA | NA | NA | 6 | 0.853 | 0.79 | 2 | 0.24 |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S NAPHTHALENE | NA | NA | NA | NA | NA | 2 | 0.19 | 0.541 | 0.21 | 0.17 |
| 8270S PHENANTHRENE | NA | NA | NA | NA | NA | 8 | 0.825 | 0.825 | 2.2 | 0.28 |
| 8270S PYRENE | NA | NA | NA | NA | NA | 8 | 1.16 | 1.16 | 2.6 | 0.4 |
| PHTHALATES | | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 0.19 U | 0.205 U | 11 | 0.2 J | 0.72 | 20 | 8.27 | 5.04 | 90 | 0.1 |
| 8270S BUTYLBENZYL PHTHALATE | NA | NA | NA | NA | NA | 1 | 0.22 | 0.696 | 0.22 | 0.22 |
| 8270S DI-N-BUTYL PHTHALATE | NA | NA | NA | NA | NA | 4 | 0.0355 | 0.462 | 0.044 | 0.023 |
| 8270S DI-N-OCTYL PHTHALATE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DIMETHYL PHTHALATE | NA | NA | NA | NA | NA | 0 | | | | |
| HALOGENATED | | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | NA | NA | NA | 1 | 0.2 | 0.606 | 0.2 | 0.2 |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | NA | NA | NA | 1 | 0.21 | 0.608 | 0.21 | 0.21 |
| 8270S 4-CHLOROANILINE | NA | NA | NA | NA | NA | 0 | | | | |
| PHENOLS | | | | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S 4-METHYLPHENOL | NA | NA | NA | NA | NA | 1 | 0.14 | 0.693 | 0.14 | 0.14 |
| 8270S PENTACHLOROPHENOL | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S PHENOL | NA | NA | NA | NA | NA | 0 | | | | |
| OTHER | | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | NA | NA | NA | NA | NA | 0 | | | | |
| FINGERPRINT COMPOUNDS | | | | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | NA | NA | NA | 2 | 0.225 | 3.04 | 0.23 | 0.22 |
| 8270S TINUVIN 328 | 0.19 U | 0.205 U | 0.36 J | 0.23 U | 0.185 U | 15 | 6.6 | 3.9 | 27 | 0.161 |
| PCBs | | | | | | | | | | |
| 8080S PCB-1221 | 0.039 U | 0.041 U | 0.064 J | 0.0465 U | 0.038 U | 3 | 2.74 | 0.299 | 7.9 | 0.064 |
| 8080S PCB-1232 | 0.019 U | 0.02 U | 0.019 U | 0.023 U | 0.019 U | 3 | 0.176 | 0.0578 | 0.4 | 0.033 |
| 8080S PCB-1242 | 0.019 U | 0.02 U | 0.019 U | 0.023 U | 0.019 U | 0 | | | | |
| 8080S PCB-1248 | 0.21 J | 0.06 | 0.13 | 0.023 U | 0.072 | 15 | 0.344 | 0.17 | 2.2 | 0.017 |
| 8080S PCB-1254 | 0.019 U | 0.02 U | 0.57 | 0.041 J | 0.039 J | 18 | 0.305 | 0.185 | 1.4 | 0.039 |
| 8080S PCB-1260 | 0.019 U | 0.02 U | 0.019 U | 0.023 U | 0.019 U | 4 | 0.0555 | 0.0478 | 0.087 | 0.017 |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | NA | NA | NA | | | | | |
| 8080S 4,4'-DDE | NA | NA | NA | NA | NA | 1 | 0.05 | 0.011 | 0.05 | 0.05 |
| 8080S 4,4'-DDT | NA | NA | NA | NA | NA | 3 | 0.00873 | 0.0108 | 0.013 | 0.0012 |
| 8080S ALDRIN | NA | NA | NA | NA | NA | 3 | 0.0217 | 0.0119 | 0.033 | 0.0051 |
| 8080S ALPHA-BHC | NA | NA | NA | NA | NA | 1 | 0.026 | 0.00621 | 0.026 | 0.026 |
| 8080S ALPHA-CHLORDANE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S BETA-BHC | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S DIELDRIN | NA | NA | NA | NA | NA | 4 | 0.0239 | 0.0132 | 0.062 | 0.0051 |
| 8080S ENDOSULFAN I | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDOSULFAN II | NA | NA | NA | NA | NA | 1 | 0.0015 | 0.00907 | 0.0015 | 0.0015 |
| 8080S ENDOSULFAN SULFATE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S ENDRIN | NA | NA | NA | NA | NA | 1 | 0.01 | 0.00603 | 0.01 | 0.01 |
| 8080S ENDRIN ALDEHYDE | NA | NA | NA | NA | NA | 0 | | | | |
| 8080S GAMMA-BHC | NA | NA | NA | NA | NA | 2 | 0.0122 | 0.00774 | 0.021 | 0.0033 |
| 8080S GAMMA-CHLORDANE | NA | NA | NA | NA | NA | 3 | 0.0268 | 0.0125 | 0.054 | 0.0073 |
| 8080S HEPTACHLOR | NA | NA | NA | NA | NA | 3 | 0.02 | 0.0115 | 0.044 | 0.002 |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | NA | NA | NA | 1 | 0.078 | 0.0138 | 0.078 | 0.078 |
| 8080S KEPONE | NA | NA | NA | NA | NA | 0 | | | | |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | | |
| 8142S DISULFOTON | NA | NA | NA | NA | NA | 3 | 0.0532 | 0.0725 | 0.12 | 0.0027 |
| 8142S METHYL PARATHION | NA | NA | NA | NA | NA | 3 | 0.017 | 0.0146 | 0.044 | 0.0024 |
| HERBICIDES | | | | | | | | | | |
| 8152S 2,4-D | NA | NA | NA | NA | NA | 1 | 0.024 | 0.0824 | 0.024 | 0.024 |
| 8152S DINOSEB | NA | NA | NA | NA | NA | 1 | 0.0049 | 0.0108 | 0.0049 | 0.0049 |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | | |
| 8270S DCDF | NA | NA | NA | NA | NA | 0 | | | | |
| 8270S DIBENZOFURAN | NA | NA | NA | NA | NA | 3 | 0.0807 | 0.43 | 0.14 | 0.046 |
| 8270S TRCDF | NA | NA | NA | NA | NA | 0 | | | | |
| SOWZS 1,2,3,4,6,7,8-HPCDD | NA | NA | 0.00007 U | 0.00012 U | NA | 1 | 0.000066 | 0.0000776 | 0.000066 | 0.000066 |
| SOWZS 1,2,3,4,6,7,8-IPCDF | NA | NA | 0.000085 U | 0.00041 J | NA | 2 | 0.000405 | 0.00013 | 0.00041 | 0.0004 |
| SOWZS 1,2,3,4,7,8,9-HPCDF | NA | NA | 0.00008 U | 0.0001 F | NA | 1 | 0.0001 | 0.0000918 | 0.0001 | 0.0001 |
| SOWZS 1,2,3,4,7,8-HXCDF | NA | NA | 0.000085 U | 0.00012 F | NA | 1 | 0.00012 | 0.0000991 | 0.00012 | 0.00012 |
| SOWZS 1,2,3,6,7,8-HXCDF | NA | NA | 0.00007 U | 0.00014 F | NA | 1 | 0.00014 | 0.0000873 | 0.00014 | 0.00014 |
| SOWZS 2,3,7,8-TCDF | NA | NA | 0.0001 U | 0.00018 U | NA | 0 | | | | |
| SOWZS HPCDD | NA | NA | 0.00007 U | 0.00012 U | NA | 1 | 0.000066 | 0.0000776 | 0.000066 | 0.000066 |
| SOWZS HPCDF | NA | NA | 0.000065 U | 0.001 J | NA | 2 | 0.000805 | 0.000191 | 0.001 | 0.00061 |
| SOWZS HXCDF | NA | NA | 0.00007 U | 0.00071 J | NA | 2 | 0.00052 | 0.000145 | 0.00071 | 0.00033 |
| SOWZS OCDD | NA | NA | 0.000315 U | 0.00069 J | NA | 7 | 0.000601 | 0.000411 | 0.00077 | 0.0004 |
| SOWZS OCPF | NA | NA | 0.000245 U | 0.000165 U | NA | 2 | 0.000265 | 0.000149 | 0.00033 | 0.0002 |
| SOWZS TCDF | NA | NA | 0.0001 U | 0.00018 U | NA | 0 | | | | |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-16
CRANSTON SITE
LOWER FACILITY REACH
RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TLF SD-04R*IB-2 3/27/91 0 to .5 Result Q | TLF SD-05L*IB-1 11/29/90 0 to .5 Result Q | TLF SD-05M*IB-2 3/28/91 0 to .5 Result Q | TLF SD-06R*IB-1 11/29/90 0 to .5 Result Q | TLF SD-07L*IB-1 11/29/90 0 to .5 Result Q | TLF SD-07L*IB-2 3/28/91 0 to .5 Result Q | TLF SD-08M*IB-1 11/29/90 0 to .5 Result Q | TLF SD-08M*IB-2 3/27/91 0 to .5 Result Q | TLF SD-DUP1*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF-12C(1-2)*II-2 7/27/94 1 to 2 Result Q | TLF SD-TLF-12C(2-4)*II-2 7/27/94 2 to 4 Result Q | TLF SD-TLF10A*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF10B*II-1 2/16/94 0 to .5 Result Q |
|---|--|---|--|---|---|--|---|--|---|--|--|---|---|
| 6010S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7041S ANTIMONY | 0.325 U | 0.33 U | 0.295 U | 0.42 U | 0.4 U | 0.9 U | 0.335 U | 0.4 U | NA | NA | NA | NA | NA |
| 6010S BARIUM | 44.4 J | 15.3 J | 14.7 J | 26.7 J | 104 J | 150 J | 15.5 J | 22.2 J | NA | NA | NA | NA | NA |
| 6010S BERYLLIUM | 0.91 J | 0.63 | 0.49 J | 0.66 | 1.8 | 2.9 J | 0.5 | 0.57 J | NA | NA | NA | NA | NA |
| 6010S CADMIUM | 0.94 J | 0.22 U | 0.19 U | 2 | 8.9 | 13.5 J | 0.22 U | 0.275 U | NA | NA | NA | NA | NA |
| 6010S CALCIUM | 1350 J | 710 J | 522 J | 657 J | 1720 J | 3070 J | 677 J | 1480 J | NA | NA | NA | NA | NA |
| 6010S CHROMIUM | 81.7 J | 15.8 J | 19.5 J | 23.1 J | 55.7 J | 77.2 J | 14.6 J | 15.4 J | NA | NA | NA | NA | NA |
| 6010S COBALT | 3.9 | 1.8 J | 2 | 2.6 J | 6.1 J | 12.8 | 2.1 J | 2.1 | NA | NA | NA | NA | NA |
| 6010S COPPER | 81.5 J | 15.2 J | 14.5 J | 21.3 J | 164 J | 226 J | 10.5 J | 6.4 U | 60.6 J | 14.1 J | 15.4 J | 28.2 J | 10.8 J |
| 6010S IRON | 9860 | 4570 | 5120 | 6360 | 12400 | 21900 | 5660 | 7510 | NA | NA | NA | NA | NA |
| 6010S MAGNESIUM | 1740 | 734 J | 931 | 913 J | 1370 J | 2460 | 996 J | 1270 | NA | NA | NA | NA | NA |
| 6010S MANGANESE | 130 | 74.2 J | 76 | 140 J | 304 J | 621 | 85.8 J | 144 | NA | NA | NA | NA | NA |
| 6010S NICKEL | 9.9 J | 2.75 U | 5.6 J | 4.7 U | 36.2 | 58.9 J | 2.6 U | 5.3 J | NA | NA | NA | NA | NA |
| 6010S POTASSIUM | 919 | 269 | 297 | 170 U | 821 | 1630 | 410 | 854 | NA | NA | NA | NA | NA |
| 6010S SILVER | 0.6 U | 0.44 U | 0.375 U | 0.55 U | 1.2 | 3.3 J | 0.44 U | 0.55 U | 2.7 | NA | NA | 0.6 U | 0.55 U |
| 6010S SODIUM | 266 | 44 U | 124 | 61 U | 71.5 U | 502 | 63.5 U | 244 | NA | NA | NA | NA | NA |
| 6010S TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SNZZS TIN | 6 U | 4.4 U | 3.75 U | 5.5 U | 19.3 | 12.5 U | 4.4 U | 5.5 U | NA | NA | NA | NA | NA |
| 6010S VANADIUM | 10.8 | 2.1 | 3.3 | 2.9 | 13.4 | 20.7 | 3.3 | 5 | NA | NA | NA | NA | NA |
| 6010S ZINC | 225 J | 47 J | 41.9 J | 63.1 J | 225 J | 370 J | 32.3 J | 43.7 J | 209 J | 46.2 | 44.7 | 40.1 J | 34.9 J |
| 7060S ARSENIC | 11.1 | 2 J | 3.5 | 3.9 J | 6.6 J | 18.3 | 3.2 J | 4.9 | 5.9 | 1.7 | 6.8 | 1.6 | 2 |
| 7421S LEAD | 79.3 J | 24.7 | 15 J | 28.4 | 127 | 200 J | 13 | 16.5 J | 95.2 J | NA | NA | 14.8 J | 50.4 J |
| 747ZS MERCURY | 0.091 | 0.028 U | 0.028 U | 0.04 U | 0.34 J | 0.35 | 0.03 U | 0.028 U | NA | NA | NA | NA | NA |
| 7740S SELENIUM | 0.463 | 0.235 U | 0.424 | 0.3 U | 0.285 U | 1.27 | 0.24 U | 0.568 | NA | NA | NA | NA | NA |
| 7841S THALLIUM | 0.463 | 0.235 U | 0.424 | 0.3 U | 0.285 U | 1.27 | 0.24 U | 0.285 U | NA | NA | NA | NA | NA |
| 9010S CYANIDE | 0.2 U | 0.265 U | 0.185 U | 0.39 U | 1.1 | 1.3 | 0.3 U | 0.155 U | NA | NA | NA | NA | NA |
| 9030S SULFIDE | 34.5 U | 6 U | 16.5 U | 45 | 350 | 720 | 6 U | 24.5 U | NA | NA | NA | NA | NA |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-16
CRANSTON SITE
LOWER FACILITY REACH
RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TLF SD-TLF11A*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF11B*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF12A*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF12B*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF1A*II-1 2/18/94 0 to .5 Result Q | TLF SD-TLF1B*II-1 2/18/94 0 to .5 Result Q | TLF SD-TLF2A*II-1 2/18/94 0 to .5 Result Q | TLF SD-TLF2B*II-1 2/18/94 0 to .5 Result Q | TLF SD-TLF3A*II-1 2/18/94 0 to .5 Result Q | TLF SD-TLF3B*II-1 2/18/94 0 to .5 Result Q | TLF SD-TLF4A*II-1 2/17/94 0 to .5 Result Q | TLF SD-TLF4B*II-1 2/17/94 0 to .5 Result Q | TLF SD-TLF5A*II-1 2/17/94 0 to .5 Result Q | TLF SD-TLF5B*II-1 2/17/94 0 to .5 Result Q |
|---|---|---|---|---|--|--|--|--|--|--|--|--|--|--|
| 6010S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7041S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S BARIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S BERYLLIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CADMIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CALCIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S CHROMIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S COBALT | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S COPPER | 77.7 J | 16.2 J | 22.4 J | 44 J | 32.4 J | 11.1 J | 8.4 J | 12.5 J | 1.4 U | 23.1 J | 134 J | 11.3 J | 68.7 J | 6.2 J |
| 6010S IRON | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S MAGNESIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S MANGANESE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S NICKEL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S POTASSIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S SILVER | 0.85 U | 0.6 U | 0.6 U | 0.6 U | 0.7 U | 0.55 U | 0.7 U | 0.55 U | 0.55 U | 0.8 U | 3 | 0.65 U | 0.85 U | 0.6 U |
| 6010S SODIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| SNZZS TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S VANADIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 6010S ZINC | 172 J | 38.5 J | 135 J | 141 J | 38.3 J | 47.7 J | 19.8 J | 45.8 J | 7.1 U | 77.6 J | 214 J | 54.4 J | 131 J | 24.5 J |
| 7060S ARSENIC | 9.4 | 2.1 | 1.5 | 2.2 | 3.2 | 3.9 | 1.4 | 2.6 | 2.2 | 2.3 | 4.2 | 2.8 | 3 | 3.1 |
| 7421S LEAD | 124 J | 13.4 J | 22.7 J | 42.4 J | 66.4 J | 18.6 J | 12.5 J | 25.4 J | 1.2 J | 27.6 J | 129 J | 27.8 J | 50.8 J | 6.8 J |
| 747ZS MERCURY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7740S SELENIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 7841S THALLIUM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 9010S CYANIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 9030S SULFIDE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-16
CRANSTON SITE
LOWER FACILITY REACH
RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TLF SD-TLF6A*II-1 2/17/94 0 to .5 Result Q | TLF SD-TLF6B*II-1 2/17/94 0 to .5 Result Q | TLF SD-TLF7A*II-1 2/17/94 0 to .5 Result Q | TLF SD-TLF7B*II-1 2/17/94 0 to .5 Result Q | TLF SD-TLF8A*II-1 2/17/94 0 to .5 Result Q | TLF SD-TLF8B*II-1 2/17/94 0 to .5 Result Q | TLF SD-TLF9A*II-1 2/16/94 0 to .5 Result Q | TLF SD-TLF9B*II-1 2/16/94 0 to .5 Result Q | LOWER FACILITY REACH SUMMARY | | | | |
|---|--|--|--|--|--|--|--|--|------------------------------|---------------------|---|---------------------|---------------------|
| | | | | | | | | | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| 6010S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 7041S ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | 0.426 | | |
| 6010S BARIUM | NA | NA | NA | NA | NA | NA | NA | NA | 8 | 49.1 | 49.1 | 150 | 14.7 |
| 6010S BERYLLIUM | NA | NA | NA | NA | NA | NA | NA | NA | 8 | 1.06 | 1.06 | 2.9 | 0.49 |
| 6010S CADMIUM | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 6.34 | 3.28 | 13.5 | 0.94 |
| 6010S CALCIUM | NA | NA | NA | NA | NA | NA | NA | NA | 8 | 1270 | 1270 | 3070 | 522 |
| 6010S CHROMIUM | NA | NA | NA | NA | NA | NA | NA | NA | 8 | 37.9 | 37.9 | 81.7 | 14.6 |
| 6010S COBALT | NA | NA | NA | NA | NA | NA | NA | NA | 8 | 4.18 | 4.18 | 12.8 | 1.8 |
| 6010S COPPER | 17.5 J | 21.7 J | 21.3 J | 16.2 J | 14 J | 11.9 J | 53.8 J | 10.3 J | 33 | 39.3 | 37.3 | 226 | 6.2 |
| 6010S IRON | NA | NA | NA | NA | NA | NA | NA | NA | 8 | 9170 | 9170 | 21900 | 4570 |
| 6010S MAGNESIUM | NA | NA | NA | NA | NA | NA | NA | NA | 8 | 1300 | 1300 | 2460 | 734 |
| 6010S MANGANESE | NA | NA | NA | NA | NA | NA | NA | NA | 8 | 197 | 197 | 621 | 74.2 |
| 6010S NICKEL | NA | NA | NA | NA | NA | NA | NA | NA | 5 | 23.2 | 15.7 | 58.9 | 5.3 |
| 6010S POTASSIUM | NA | NA | NA | NA | NA | NA | NA | NA | 7 | 743 | 671 | 1630 | 269 |
| 6010S SILVER | 0.6 U | 0.6 U | 0.6 U | 0.6 U | 0.6 U | 0.6 U | 0.7 U | 0.55 U | 4 | 2.55 | 0.841 | 3.3 | 1.2 |
| 6010S SODIUM | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 284 | 172 | 502 | 124 |
| 6010S TIN | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | | | |
| SNZZS TIN | NA | NA | NA | NA | NA | NA | NA | NA | 1 | 19.3 | 7.67 | 19.3 | 19.3 |
| 6010S VANADIUM | NA | NA | NA | NA | NA | NA | NA | NA | 8 | 7.69 | 7.69 | 20.7 | 2.1 |
| 6010S ZINC | 58.6 J | 59.3 J | 37.3 J | 32.3 J | 33.2 J | 29.7 J | 179 J | 41.8 J | 34 | 89.2 | 86.9 | 370 | 19.8 |
| 7060S ARSENIC | 1.9 | 7 | 3 | 1.9 | 1.3 | 3.4 | 5.6 | 0.55 U | 34 | 4.1 | 4 | 18.3 | 1.3 |
| 7421S LEAD | 38 J | 27.1 J | 20.1 J | 15.7 J | 15.8 J | 12.8 J | 99.5 J | 27.9 J | 33 | 45.1 | 45.1 | 200 | 1.2 |
| 7472S MERCURY | NA | NA | NA | NA | NA | NA | NA | NA | 3 | 0.26 | 0.117 | 0.35 | 0.091 |
| 7740S SELENIUM | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 0.681 | 0.473 | 1.27 | 0.424 |
| 7841S THALLIUM | NA | NA | NA | NA | NA | NA | NA | NA | 3 | 0.719 | 0.438 | 1.27 | 0.424 |
| 9010S CYANIDE | NA | NA | NA | NA | NA | NA | NA | NA | 2 | 1.2 | 0.487 | 1.3 | 1.1 |
| 9030S SULFIDE | NA | NA | NA | NA | NA | NA | NA | NA | 3 | 372 | 150 | 720 | 45 |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-17
CRANSTON SITE
DOWNSTREAM REACH
RIVER SEDIMENT
ORGANIC DATA

| REACH | TD | TD | TD | TD | TD | TD | TD | TD | TD | TD | TD | TD |
|----------------------------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|
| SAMPLE ID | SD-09AL*IB-1 | SD-09R*IB-2 | SD-10M*IB-1 | SD-13R*IB-2 | SD-16M*IB-2 | SD-20M*IB-1 | SD-20M*IB-2 | SD-TD1A*II-1 | SD-TD1B*II-1 | SD-TD2A*II-1 | SD-TD2B*II-1 | SD-TD3A*II-1 |
| COLLECTION DATE | 12/7/90 | 3/27/91 | 11/29/90 | 3/27/91 | 3/29/91 | 11/29/90 | 3/29/91 | 2/15/94 | 2/15/94 | 2/15/94 | 2/15/94 | 2/15/94 |
| DEPTH RANGE (FT) | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 | 0 to .5 |
| Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q |
| VOLATILE ORGANICS | | | | | | | | | | | | |
| HALOGENATED | | | | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | 0.06 U | 0.052 J | 0.07 U | 0.09 U | 0.065 U | 0.055 U | 0.06 U | NA | NA | NA | NA | NA |
| 8240S CHLOROBENZENE | 0.06 U | 0.11 J | 0.07 U | 0.072 J | 0.065 U | 0.055 U | 0.06 U | 0.003 U | 0.003 U | 0.0032 U | 0.0028 U | 21 J |
| 8240S TRANS-1,2-DICHLOROETHENE | 0.06 U | 0.065 U | 0.07 U | 0.09 U | 0.065 U | 0.055 U | 0.06 U | NA | NA | NA | NA | NA |
| AROMATICS | | | | | | | | | | | | |
| 8240S BENZENE | 0.06 U | 0.065 U | 0.07 U | 0.09 U | 0.065 U | 0.055 U | 0.06 U | NA | NA | NA | NA | NA |
| 8240S ETHYLBENZENE | 0.06 U | 0.065 U | 0.07 U | 0.09 U | 0.065 U | 0.055 U | 0.06 U | NA | NA | NA | NA | NA |
| 8240S M&P-XYLENE | 0.06 U | 0.065 U | 0.07 U | 0.09 U | 0.065 U | 0.055 U | 0.06 U | NA | NA | NA | NA | NA |
| 8240S NAPHTHALENE | NA | NA | NA | NA | NA | NA | NA | 0.015 | 0.003 U | 0.0032 U | 0.0028 U | 2.4 J |
| 8240S O-XYLENE | 0.06 U | 0.065 U | 0.07 U | 0.09 U | 0.065 U | 0.055 U | 0.06 U | NA | NA | NA | NA | NA |
| 8240S TOLUENE | 0.06 U | 0.068 J | 0.07 U | 0.14 J | 0.065 U | 0.055 U | 0.06 U | 0.003 U | 0.003 U | 0.0032 U | 0.0028 U | 6.1 J |
| KETONES / ALDEHYDES | | | | | | | | | | | | |
| 8240S 2-BUTANONE | 0.125 U | 0.2 J | 0.14 U | 0.2 J | 0.13 U | 0.115 U | 0.13 J | NA | NA | NA | NA | NA |
| 8240S 2-HEXANONE | 0.125 U | 0.13 U | 0.14 U | 0.175 U | 0.13 U | 0.115 U | 0.12 U | NA | NA | NA | NA | NA |
| 8240S 4-METHYL-2-PENTANONE | 0.125 U | 0.13 U | 0.14 U | 0.175 U | 0.13 U | 0.115 U | 0.12 U | NA | NA | NA | NA | NA |
| 8240S ACETONE | 0.125 U | 0.13 U | 0.14 U | 0.175 U | 0.13 U | 0.115 U | 0.12 U | NA | NA | NA | NA | NA |
| SEMI-VOLATILE ORGANICS | | | | | | | | | | | | |
| PAHs | | | | | | | | | | | | |
| 8270S ACENAPHTHENE | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S ACENAPHTHYLENE | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S ANTHRACENE | 0.13 J | 0.085 J | 0.16 J | 0.2 J | 0.054 J | 0.044 J | R | NA | NA | NA | NA | NA |
| 8270S BENZO(A)ANTHRACENE | 0.42 J | 0.5 J | 0.67 J | 1 J | 0.35 J | 0.24 J | R | NA | NA | NA | NA | NA |
| 8270S BENZO(A)PYRENE | 0.43 J | 0.52 J | 0.56 J | 1 J | 0.31 J | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S BENZO(B)FLUORANTHENE | 0.65 J | 0.92 J | 1.1 J | 1.8 | 0.46 J | 0.33 J | R | NA | NA | NA | NA | NA |
| 8270S BENZO(G,H,I)PERYLENE | 0.6 U | 0.57 J | 0.65 U | 0.95 J | 0.25 J | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S BENZO(K)FLUORANTHENE | 0.82 J | 1 J | 1.2 J | 2.1 | 0.52 J | 0.34 J | R | NA | NA | NA | NA | NA |
| 8270S CHRYSENE | 0.6 J | 0.71 J | 0.79 J | 1.4 J | 0.41 J | 0.3 J | 0.15 J | NA | NA | NA | NA | NA |
| 8270S DIBENZO(A,H)ANTHRACENE | 0.6 U | 0.2 J | 0.65 U | 0.85 U | 0.13 J | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S FLUORANTHENE | 1.1 J | 1.8 | 1.3 | 3.6 | 1 J | 0.56 J | 0.32 J | NA | NA | NA | NA | NA |
| 8270S FLUORENE | 0.6 U | 0.65 U | 0.065 J | 0.1 J | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S INDENO(1,2,3-CD)PYRENE | 0.27 J | 0.47 J | 0.65 U | 0.83 J | 0.24 J | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S 2-METHYLNAPHTHALENE | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.049 J | R | NA | NA | NA | NA | NA |
| 8270S NAPHTHALENE | 0.23 J | 0.061 J | 0.65 U | 0.089 J | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S PHENANTHRENE | 0.74 J | 0.52 J | 0.77 J | 1.2 J | 0.27 J | 0.59 J | 0.12 J | NA | NA | NA | NA | NA |
| 8270S PYRENE | 0.92 J | 0.6 J | 1.5 | 1.2 J | 0.35 J | 0.72 J | 0.14 J | NA | NA | NA | NA | NA |
| PHTHALATES | | | | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 0.84 J | 0.65 U | 4.1 | 0.85 U | 0.6 U | 1.5 | 0.6 U | 3.4 | 16 | 9.9 J | 3.1 | 6.3 |
| 8270S BUTYLBENZYLPHthalATE | 0.6 U | 0.65 U | 0.24 J | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S DI-N-BUTYLPHthalATE | 0.6 U | 0.65 U | 0.053 J | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S DI-N-OCTYLPHthalATE | 0.6 U | 0.65 U | 1.4 | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S DIMETHYLPHthalATE | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| HALOGENATED | | | | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S 1,2-DICHLOROBENZENE | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S 1,3-DICHLOROBENZENE | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S 1,4-DICHLOROBENZENE | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S 4-CHLOROANILINE | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| PHENOLS | | | | | | | | | | | | |
| 8270S 2-METHYLPHENOL | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8270S 4-METHYLPHENOL | 0.6 U | 0.17 J | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| 8270S PENTACHLOROPHENOL | 3.05 U | 3.15 U | 3.35 U | 4.3 U | 3.1 U | 2.85 U | R | NA | NA | NA | NA | NA |
| 8270S PHENOL | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | 1.1 J | NA | NA | NA | NA | NA |
| OTHER | | | | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | 0.6 U | 0.65 U | 0.65 U | 0.85 U | 0.6 U | 0.55 U | R | NA | NA | NA | NA | NA |
| FINGERPRINT COMPOUNDS | | | | | | | | | | | | |
| 8270S TINUVIN 327 | 3.05 U | 3.15 U | 1.2 J | 4.3 U | 3.1 U | 0.18 J | R | NA | NA | NA | NA | NA |
| 8270S TINUVIN 328 | NA | NA | NA | NA | NA | NA | NA | 1.4 | 4 | 0.13 J | 0.185 U | 0.315 U |
| PCBs | | | | | | | | | | | | |
| 8080S PCB-1221 | R | 0.013 U | 0.265 U | 0.0175 U | 0.013 U | 0.055 U | 0.0115 U | 0.04 U | 0.04 U | 0.043 U | 0.0375 U | 0.32 U |
| 8080S PCB-1232 | R | 0.013 U | 0.265 U | 0.0175 U | 0.013 U | 0.055 U | 0.0115 U | 0.0195 U | 0.0195 U | 0.021 U | 0.0185 U | 0.16 U |
| 8080S PCB-1242 | R | 0.0065 U | 0.135 U | 0.009 U | 0.0065 U | 0.028 U | 0.0055 U | 0.0195 U | 0.0195 U | 0.021 U | 0.0185 U | 0.16 U |
| 8080S PCB-1248 | R | 0.0065 U | 0.135 U | 0.009 U | 0.0065 U | 0.028 U | 0.0055 U | 0.097 J | 0.086 | 0.061 | 0.092 J | 1.2 |
| 8080S PCB-1254 | R | 0.013 U | 0.265 U | 0.0175 U | 0.013 U | 0.055 U | 0.0115 U | 0.083 J | 0.034 J | 0.04 J | 0.037 J | 1.4 |
| 8080S PCB-1260 | R | 0.013 U | 0.265 U | 0.0175 U | 0.013 U | 0.055 U | 0.0115 U | 0.0195 U | 0.0195 U | 0.021 U | 0.0185 U | 0.84 |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | | | | |
| 8080S 4,4'-DDD | R | 0.00065 U | 0.0135 U | 0.0009 U | 0.00065 U | 0.0028 U | 0.0019 | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDE | R | 0.007 | 0.0135 U | 0.0009 U | 0.00065 U | 0.0028 U | 0.00055 U | NA | NA | NA | NA | NA |
| 8080S 4,4'-DDT | R | 0.0013 U | 0.0285 U | 0.0062 | 0.0013 U | 0.0055 U | 0.00115 U | NA | NA | NA | NA | NA |
| 8080S ALDRIN | R | 0.0049 | 0.0135 U | 0.015 | 0.0061 | 0.0028 U | 0.0055 | NA | NA | NA | NA | NA |
| 8080S ALPHA-BHC | R | 0.00065 U | 0.0135 U | 0.0009 U | 0.00065 U | 0.0028 U | 0.00055 U | NA | NA | NA | NA | NA |
| 8080S ALPHA-CHLORDANE | R | 0.007 | 0.0135 U | 0.0009 U | 0.00065 U | 0.0028 U | 0.00055 U | NA | NA | NA | NA | NA |
| 8080S BETA-BHC | R | 0.00065 U | 0.0135 U | 0.0009 U | 0.00065 U | 0.0028 U | 0.00055 U | NA | NA | NA | NA | NA |
| 8080S CHLOROBENZILATE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8080S DIELDRIN | R | 0.00065 U | 0.025 J | 0.014 | 0.00065 U | 0.0028 U | 0.00055 U | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN I | R | 0.00065 U | 0.0135 U | 0.0009 U | 0.00065 U | 0.0028 U | 0.00055 U | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN II | R | 0.0019 U | 0.04 U | 0.00265 U | 0.00195 U | 0.0085 U | 0.0017 U | NA | NA | NA | NA | NA |
| 8080S ENDOSULFAN SULFATE | R | 0.0032 U | 0.065 U | 0.0044 U | 0.0032 U | 0.014 U | 0.00285 U | NA | NA | NA | NA | NA |
| 8080S ENDRIN | R | 0.00065 U | 0.0135 U | 0.0009 U | 0.00065 U | 0.0028 U | 0.00055 U | NA | NA | NA | NA | NA |
| 8080S ENDRIN ALDEHYDE | R | 0.0013 U | 0.0265 U | 0.043 | 0.0013 U | 0.0055 U | 0.00115 U | NA | NA | NA | NA | NA |
| 8080S GAMMA-BHC | R | 0.00065 U | 0.0135 U | 0.009 | 0.0037 | 0.0028 U | 0.00055 U | NA | NA | NA | NA | NA |
| 8080S GAMMA-CHLORDANE | R | 0.00065 U | 0.0135 U | 0.0009 U | 0.00065 U | 0.0028 U | 0.0041 | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR | R | 0.0033 | 0.0135 U | 0.025 | 0.0022 | 0.0028 U | 0.0014 | NA | NA | NA | NA | NA |
| 8080S HEPTACHLOR EPOXIDE | R | 0.00065 U | 0.0135 U | 0.026 | 0.00065 U | 0.0028 U | 0.00055 U | NA | NA | NA | NA | NA |
| 8080S KEPONE | R | 0.00065 U | 0.0135 U | 0.0009 U | 0.00065 U | 0.0028 U | 0.00055 U | NA | NA | NA | NA | NA |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | | | | |
| 814ZS DISULFOTON | 0.06 U | 0.065 U | 0.135 U | 0.085 U | 0.06 U | 0.055 U | 0.06 U | NA | NA | NA | NA | NA |
| 814ZS METHYL PARATHION | 0.0095 U | 0.01 U | 0.02 | | | | | | | | | |

TABLE 4-17
CRANSTON SITE
DOWNSTREAM REACH
RIVER SEDIMENT
ORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | TD SD-TD3B*II-1 2/15/94 0 to .5 Result Q | TD SD-TD4A*II-1 2/15/94 0 to .5 Result Q | TD SD-TD4B*II-1 2/15/94 0 to .5 Result Q | DOWNSTREAM SUMMARY | | | | | |
|---|--|--|--|------------------------------|---------------------|---|---------------------|---------------------|--|
| | | | | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected | |
| VOLATILE ORGANICS | | | | | | | | | |
| HALOGENATED | | | | | | | | | |
| 8240S 1,1,2,2-TETRACHLOROETHANE | NA | NA | NA | 1 | 0.052 | 0.0646 | 0.052 | 0.052 | |
| 8240S CHLOROBENZENE | 0.016 | 0.005 U | 0.041 J | 5 | 4.25 | 1.44 | 21 | 0.016 | |
| 8240S TRANS-1,2-DICHLOROETHENE | NA | NA | NA | 0 | | | | | |
| AROMATICS | | | | | | | | | |
| 8240S BENZENE | NA | NA | NA | 0 | | | | | |
| 8240S ETHYLBENZENE | NA | NA | NA | 0 | | | | | |
| 8240S M&P-XYLENE | NA | NA | NA | 0 | | | | | |
| 8240S NAPHTHALENE | 0.00385 U | 0.005 U | 0.0031 U | 2 | 1.21 | 0.304 | 2.4 | 0.015 | |
| 8240S O-XYLENE | NA | NA | NA | 0 | | | | | |
| 8240S TOLUENE | 0.021 | 0.005 U | 0.0031 U | 4 | 1.58 | 0.444 | 6.1 | 0.021 | |
| KETONES / ALDEHYDES | | | | | | | | | |
| 8240S 2-BUTANONE | NA | NA | NA | 3 | 0.177 | 0.149 | 0.2 | 0.13 | |
| 8240S 2-HEXANONE | NA | NA | NA | 0 | | | | | |
| 8240S 4-METHYL-2-PENTANONE | NA | NA | NA | 0 | | | | | |
| 8240S ACETONE | NA | NA | NA | 0 | | | | | |
| SEMI-VOLATILE ORGANICS | | | | | | | | | |
| PAHs | | | | | | | | | |
| 8270S ACENAPHTHENE | NA | NA | NA | 0 | | | | | |
| 8270S ACENAPHTHYLENE | NA | NA | NA | 0 | | | | | |
| 8270S ANTHRACENE | NA | NA | NA | 6 | 0.112 | 0.112 | 0.2 | 0.044 | |
| 8270S BENZO(A)ANTHRACENE | NA | NA | NA | 6 | 0.53 | 0.53 | 1 | 0.24 | |
| 8270S BENZO(A)PYRENE | NA | NA | NA | 5 | 0.564 | 0.562 | 1 | 0.31 | |
| 8270S BENZO(B)FLUORANTHENE | NA | NA | NA | 6 | 0.877 | 0.877 | 1.8 | 0.33 | |
| 8270S BENZO(G,H,I)PERYLENE | NA | NA | NA | 3 | 0.59 | 0.595 | 0.95 | 0.25 | |
| 8270S BENZO(K)FLUORANTHENE | NA | NA | NA | 6 | 0.997 | 0.997 | 2.1 | 0.34 | |
| 8270S CHRYSENE | NA | NA | NA | 7 | 0.623 | 0.623 | 1.4 | 0.15 | |
| 8270S DIBENZO(A,H)ANTHRACENE | NA | NA | NA | 2 | 0.165 | 0.497 | 0.2 | 0.13 | |
| 8270S FLUORANTHENE | NA | NA | NA | 7 | 1.38 | 1.38 | 3.6 | 0.32 | |
| 8270S FLUORENE | NA | NA | NA | 2 | 0.0825 | 0.428 | 0.1 | 0.065 | |
| 8270S INDENO(1,2,3-CD)PYRENE | NA | NA | NA | 4 | 0.453 | 0.502 | 0.83 | 0.24 | |
| 8270S 2-METHYLNAPHTHALENE | NA | NA | NA | 1 | 0.049 | 0.567 | 0.049 | 0.049 | |
| 8270S NAPHTHALENE | NA | NA | NA | 3 | 0.127 | 0.363 | 0.23 | 0.061 | |
| 8270S PHENANTHRENE | NA | NA | NA | 7 | 0.601 | 0.601 | 1.2 | 0.12 | |
| 8270S PYRENE | NA | NA | NA | 7 | 0.776 | 0.776 | 1.5 | 0.14 | |
| PHTHALATES | | | | | | | | | |
| 8270S BIS(2-ETHYLHEXYL)PHTHALATE | 3.9 | 1.4 J | 5.2 | 11 | 5.06 | 3.89 | 16 | 0.84 | |
| 8270S BUTYLBENZYLPHthalATE | NA | NA | NA | 1 | 0.24 | 0.582 | 0.24 | 0.24 | |
| 8270S DI-N-BUTYLPHthalATE | NA | NA | NA | 1 | 0.053 | 0.551 | 0.053 | 0.053 | |
| 8270S DI-N-OCTYLPHthalATE | NA | NA | NA | 1 | 1.4 | 0.775 | 1.4 | 1.4 | |
| 8270S DIMETHYLPHthalATE | NA | NA | NA | 0 | | | | | |
| HALOGENATED | | | | | | | | | |
| 8270S 1,2,4-TRICHLOROBENZENE | NA | NA | NA | 0 | | | | | |
| 8270S 1,2-DICHLOROBENZENE | NA | NA | NA | 0 | | | | | |
| 8270S 1,3-DICHLOROBENZENE | NA | NA | NA | 0 | | | | | |
| 8270S 1,4-DICHLOROBENZENE | NA | NA | NA | 0 | | | | | |
| 8270S 4-CHLOROANILINE | NA | NA | NA | 0 | | | | | |
| PHENOLS | | | | | | | | | |
| 8270S 2-METHYLPHENOL | NA | NA | NA | 0 | | | | | |
| 8270S 3&4-METHYLPHENOL | NA | NA | NA | 0 | | | | | |
| 8270S 4-METHYLPHENOL | NA | NA | NA | 1 | 0.17 | 0.57 | 0.17 | 0.17 | |
| 8270S PENTACHLOROPHENOL | NA | NA | NA | 0 | | | | | |
| 8270S PHENOL | NA | NA | NA | 1 | 1.1 | 0.714 | 1.1 | 1.1 | |
| OTHER | | | | | | | | | |
| 8270S 5-NITRO-O-TOLUIDINE | NA | NA | NA | 0 | | | | | |
| FINGERPRINT COMPOUNDS | | | | | | | | | |
| 8270S TINUVIN 327 | NA | NA | NA | 2 | 0.69 | 2.5 | 1.2 | 0.18 | |
| 8270S TINUVIN 328 | 5.9 | 2.4 J | 92 J | 6 | 17.6 | 13.3 | 92 | 0.13 | |
| PCBs | | | | | | | | | |
| 8080S PCB-1221 | 0.05 U | 0.07 U | 0.0415 U | 0 | | | | | |
| 8080S PCB-1232 | 0.0255 U | 0.0335 U | 0.0205 U | 0 | | | | | |
| 8080S PCB-1242 | 0.0255 U | 0.0335 U | 0.0205 U | 0 | | | | | |
| 8080S PCB-1248 | 0.086 J | 0.093 J | 0.11 | 8 | 0.228 | 0.144 | 1.2 | 0.061 | |
| 8080S PCB-1254 | 0.1 J | 0.065 J | 0.085 | 8 | 0.231 | 0.159 | 1.4 | 0.034 | |
| 8080S PCB-1260 | 0.0255 U | 0.0335 U | 0.0205 U | 1 | 0.84 | 0.0981 | 0.84 | 0.84 | |
| ORGANOCHLORINE PESTICIDES | | | | | | | | | |
| 8080S 4,4'-DDD | NA | NA | NA | 1 | 0.0019 | 0.0034 | 0.0019 | 0.0019 | |
| 8080S 4,4'-DDE | NA | NA | NA | 1 | 0.007 | 0.00423 | 0.007 | 0.007 | |
| 8080S 4,4'-DDT | NA | NA | NA | 1 | 0.0062 | 0.00699 | 0.0062 | 0.0062 | |
| 8080S ALDRIN | NA | NA | NA | 4 | 0.00788 | 0.00797 | 0.015 | 0.0049 | |
| 8080S ALPHA-BHC | NA | NA | NA | 0 | | | | | |
| 8080S ALPHA-CHLORDANE | NA | NA | NA | 1 | 0.007 | 0.00423 | 0.007 | 0.007 | |
| 8080S BETA-BHC | NA | NA | NA | 0 | | | | | |
| 8080S CHLOROBENZILATE | NA | NA | NA | 0 | | | | | |
| 8080S DIELDRIN | NA | NA | NA | 2 | 0.0195 | 0.00728 | 0.025 | 0.014 | |
| 8080S ENDOSULFAN I | NA | NA | NA | 0 | | | | | |
| 8080S ENDOSULFAN II | NA | NA | NA | 0 | | | | | |
| 8080S ENDOSULFAN SULFATE | NA | NA | NA | 0 | | | | | |
| 8080S ENDRIN | NA | NA | NA | 0 | | | | | |
| 8080S ENDRIN ALDEHYDE | NA | NA | NA | 1 | 0.043 | 0.0131 | 0.043 | 0.043 | |
| 8080S GAMMA-BHC | NA | NA | NA | 2 | 0.00635 | 0.00503 | 0.009 | 0.0037 | |
| 8080S GAMMA-CHLORDANE | NA | NA | NA | 1 | 0.0041 | 0.00377 | 0.0041 | 0.0041 | |
| 8080S HEPTACHLOR | NA | NA | NA | 4 | 0.00798 | 0.00803 | 0.025 | 0.0014 | |
| 8080S HEPTACHLOR EPOXIDE | NA | NA | NA | 1 | 0.026 | 0.00736 | 0.026 | 0.026 | |
| 8080S KEPONE | NA | NA | NA | 0 | | | | | |
| ORGANOPHOSPHOROUS PESTICIDES | | | | | | | | | |
| 814ZS DISULFOTON | NA | NA | NA | 0 | | | | | |
| 814ZS METHYL PARATHION | NA | NA | NA | 1 | 0.0051 | 0.0109 | 0.0051 | 0.0051 | |
| HERBICIDES | | | | | | | | | |
| 815ZS 2,4-D | NA | NA | NA | 0 | | | | | |
| 815ZS DINOSEB | NA | NA | NA | 2 | 0.0155 | 0.0116 | 0.018 | 0.013 | |
| CHLORINATED DIOXINS AND FURANS | | | | | | | | | |
| 8270S DCDF | NA | NA | NA | 0 | | | | | |
| 8270S DIBENZOFURAN | NA | NA | NA | 1 | 0.067 | 0.52 | 0.067 | 0.067 | |
| 8270S TRCDF | NA | NA | NA | 1 | 0.26 | 1.15 | 0.26 | 0.26 | |
| SOWZS 1,2,3,4,6,7,8-HPCDD | 0.000095 U | NA | 0.000071 J | 1 | 0.000071 | 0.0000828 | 0.000071 | 0.000071 | |
| SOWZS 1,2,3,4,6,7,8-HPCDF | 0.00051 J | NA | 0.00006 U | 1 | 0.00051 | 0.00017 | 0.00051 | 0.00051 | |
| SOWZS 1,2,3,4,7,8,9-HPCDF | 0.000105 U | NA | 0.000075 U | 0 | | | | | |
| SOWZS 1,2,3,4,7,8-HXCDF | 0.00015 J | NA | 0.00008 U | 1 | 0.00015 | 0.0001 | 0.00015 | 0.00015 | |
| SOWZS 1,2,3,6,7,8-HXCDF | 0.00015 J | NA | 0.000065 U | 1 | 0.00015 | 0.0000888 | 0.00015 | 0.00015 | |
| SOWZS 2,3,7,8-TCDF | 0.00014 U | NA | 0.000061 F | 1 | 0.000061 | 0.000103 | 0.000061 | 0.000061 | |
| SOWZS HPCDD | 0.000095 U | NA | 0.00014 J | 1 | 0.00014 | 0.0001 | 0.00014 | 0.00014 | |
| SOWZS HPCDF | 0.0011 J | NA | 0.00006 U | 1 | 0.0011 | 0.000318 | 0.0011 | 0.0011 | |
| SOWZS HXCDF | 0.001 J | NA | 0.000065 U | 1 | 0.001 | 0.000301 | 0.001 | 0.001 | |
| SOWZS OCDD | 0.00054 J | NA | 0.00009 J | 3 | 0.000697 | 0.000583 | 0.0009 | 0.00054 | |
| SOWZS OCDF | 0.00037 F | NA | 0.00027 U | 1 | 0.00037 | 0.00025 | 0.00037 | 0.00037 | |
| SOWZS TCDF | 0.00014 U | NA | 0.0014 | 1 | 0.0014 | 0.000438 | 0.0014 | 0.0014 | |

All results in mg/kg (ppm).
All non-detected result reported at one half the detection limit.
U - non-detected.
J - Estimated.
R - Rejected.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-18
CRANSTON SITE
DOWNSTREAM REACH
RIVER SEDIMENT
INORGANIC DATA

| REACH SAMPLE ID COLLECTION DATE DEPTH RANGE (FT) | | TD | TD | TD | TD | TD | TD | TD | TD | TD | TD | TD | TD | TD | TD | TD | DOWNSTREAM SUMMARY | | | | |
|---|-----------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|------------------------------|---------------------|---|---------------------|---------------------|
| | | SD-09AL*IB-1 | SD-09R*IB-2 | SD-10M*IB-1 | SD-13R*IB-2 | SD-16M*IB-2 | SD-20M*IB-1 | SD-20M*IB-2 | SD-TD1A*II-1 | SD-TD1B*II-1 | SD-TD2A*II-1 | SD-TD2B*II-1 | SD-TD3A*II-1 | SD-TD3B*II-1 | SD-TD4A*II-1 | SD-TD4B*II-1 | Frequency of Detection | Average Detected | Average Reported (with 1/2 detection limit) | Maximum Detected | Minimum Detected |
| | | 12/7/90 | 3/27/91 | 11/29/90 | 3/27/91 | 3/29/91 | 11/29/90 | 3/29/91 | 2/15/94 | 2/15/94 | 2/15/94 | 2/15/94 | 2/15/94 | 2/15/94 | 2/15/94 | 2/15/94 | 0 to .5 Result Q | 0 to .5 Result Q | 0 to .5 Result Q | 0 to .5 Result Q | 0 to .5 Result Q |
| 6010S | ANTIMONY | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 7041S | ANTIMONY | R | 0.335 U | 0.375 U | 0.405 U | 0.31 U | 0.305 U | 0.295 U | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S | BARIUM | 6.5 | 38.6 J | 27 J | 80.5 J | 23.7 J | 15.7 J | 17.5 J | NA | NA | NA | NA | NA | NA | NA | NA | 7 | 29.9 | 29.9 | 80.5 | 6.5 |
| 6010S | BERYLLIUM | 0.1 U | 0.81 J | 0.57 | 1.7 J | 0.69 J | 0.49 | 0.64 J | NA | NA | NA | NA | NA | NA | NA | NA | 6 | 0.817 | 0.714 | 1.7 | 0.49 |
| 6010S | CADMIUM | 0.25 U | 3.4 J | 1.6 | 6.5 J | 0.255 U | 0.2 U | 0.25 U | NA | NA | NA | NA | NA | NA | NA | NA | 3 | 3.83 | 1.78 | 6.5 | 1.6 |
| 6010S | CALCIUM | 340 J | 1150 J | 1250 J | 3800 J | 784 J | 527 J | 513 J | NA | NA | NA | NA | NA | NA | NA | NA | 7 | 1190 | 1190 | 3800 | 340 |
| 6010S | CHROMIUM | 5.6 | 21.9 J | 15.9 J | 44.5 J | 19.4 J | 9.3 J | 11.9 J | NA | NA | NA | NA | NA | NA | NA | NA | 7 | 18.4 | 18.4 | 44.5 | 5.6 |
| 6010S | COBALT | 1.6 | 4 | 3.3 | 5.9 | 3.6 | 1.3 J | 1.9 | NA | NA | NA | NA | NA | NA | NA | NA | 7 | 3.09 | 3.09 | 5.9 | 1.3 |
| 6010S | COPPER | 5.8 | 48.6 J | 21.5 J | 117 J | 16.6 J | 4 J | 5.55 U | 44.8 J | 20.1 J | 47.2 J | 17.4 J | 236 J | 83.4 J | 134 J | 68.5 J | 14 | 61.8 | 58 | 236 | 4 |
| 6010S | IRON | 7200 | 8320 | 6910 | 11600 | 8550 | 5760 | 6750 | NA | NA | NA | NA | NA | NA | NA | NA | 7 | 7870 | 7870 | 11600 | 5760 |
| 6010S | MAGNESIUM | 760 J | 1450 | 1020 J | 1390 | 1320 | 502 J | 482 | NA | NA | NA | NA | NA | NA | NA | NA | 7 | 989 | 989 | 1450 | 482 |
| 6010S | MANGANESE | 120 J | 129 | 164 J | 353 | 199 | 79.9 J | 198 | NA | NA | NA | NA | NA | NA | NA | NA | 7 | 178 | 178 | 353 | 79.9 |
| 6010S | NICKEL | 1.9 U | 16 J | 5.8 U | 23.2 J | 7.8 J | 1.45 U | 4.8 J | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 13 | 8.71 | 23.2 | 4.8 |
| 6010S | POTASSIUM | 150 U | 633 | 554 | 921 | 435 | 327 | 150 U | NA | NA | NA | NA | NA | NA | NA | NA | 5 | 574 | 453 | 921 | 327 |
| 6010S | SILVER | 0.5 U | 0.5 U | 0.5 U | 0.75 U | 0.5 U | 0.395 U | 0.495 U | 0.6 U | 0.6 U | 0.65 U | 0.55 U | 0.95 U | 0.75 U | 1 U | 1.6 | 1 | 1.6 | 0.689 | 1.6 | 1.6 |
| 6010S | SODIUM | 50 U | 225 | 50 U | 423 | 155 | 39.5 U | 176 | NA | NA | NA | NA | NA | NA | NA | NA | 4 | 245 | 160 | 423 | 155 |
| 6010S | TIN | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | | | |
| SNZZS | TIN | 5 U | 5 U | 5 U | 7.5 U | 5 U | 3.95 U | 4.95 U | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 6010S | VANADIUM | 4.1 | 7.9 | 4.5 | 10.2 | 4.6 | 0.8 U | 1 U | NA | NA | NA | NA | NA | NA | NA | NA | 5 | 6.26 | 4.73 | 10.2 | 4.1 |
| 6010S | ZINC | 36 | 113 J | 58.4 J | 195 J | 50.4 J | 31.3 J | 44.3 J | 80 J | 33.1 J | 41.2 J | 45.6 J | 457 J | 223 J | 511 J | 174 J | 15 | 140 | 140 | 511 | 31.3 |
| 7060S | ARSENIC | 2 J | 8.9 | 2.2 J | 10.5 | 4.4 | 2.9 J | 4.4 | 2 | 1.6 | 1.6 | 1.3 | 4.1 | 4.1 | 9.8 | 2.5 | 15 | 4.15 | 4.15 | 10.5 | 1.3 |
| 7421S | LEAD | 128 J | 70.9 J | 18.5 | 84.9 J | 13.9 J | 13.6 | 13.5 J | 39.4 J | 15.6 J | 31 J | 16.7 J | 126 J | 102 J | 151 J | 52.2 J | 15 | 58.5 | 58.5 | 151 | 13.5 |
| 747ZS | MERCURY | 0.03 U | 0.16 | 0.03 U | 0.041 U | 0.03 U | 0.025 U | 0.0265 U | NA | NA | NA | NA | NA | NA | NA | NA | 1 | 0.16 | 0.0489 | 0.16 | 0.16 |
| 7740S | SELENIUM | 0.305 U | 0.476 | 0.27 U | 0.578 | 0.442 | 0.22 U | 0.21 U | NA | NA | NA | NA | NA | NA | NA | NA | 3 | 0.499 | 0.357 | 0.578 | 0.442 |
| 7841S | THALLIUM | 0.305 U | 0.24 U | 0.27 U | 0.578 | 0.442 | 0.22 U | 0.21 U | NA | NA | NA | NA | NA | NA | NA | NA | 2 | 0.51 | 0.324 | 0.578 | 0.442 |
| 9010S | CYANIDE | R | 0.165 U | 0.305 U | 0.195 U | 0.155 U | 0.215 U | 0.135 U | NA | NA | NA | NA | NA | NA | NA | NA | 0 | | | | |
| 9030S | SULFIDE | 120 | 29 U | 36 | 40.5 U | 110 | 6 U | 14.5 U | NA | NA | NA | NA | NA | NA | NA | NA | 3 | 88.7 | 50.9 | 120 | 36 |

All results in mg/kg (ppm).
U - non-detected (non-detected results are listed at one-half the reported detection limit).
R - Rejected.
J - Estimated.
F - Estimated maximum.
NA - Not analyzed.

TABLE 4-19
RESULTS OF MEAN COMPARISON TEST
SUFACE SEDIMENTS BY REACH

| Phase II Analyte | Statistical Difference | Comments |
|----------------------------|------------------------|--|
| Copper | Yes | Upper Facility Reach is significantly greater than remaining reaches. |
| Silver | Yes | Upper Facility Reach is significantly greater than remaining reaches. |
| Zinc | Yes | Upper Facility Reach is significantly greater than remaining reaches. |
| Arsenic | Yes | Upper Facility Reach is significantly greater than remaining reaches. |
| Lead | Yes | Upper Facility Reach is significantly greater than Lower Facility and Downstream; No difference between Upstream and Upper Facility Reaches. |
| PCBs | Yes | Upper Facility Reach is significantly greater than remaining reaches. |
| Chlorobenzene | Yes | Upper Facility Reach is significantly greater than remaining reaches. |
| Naphthalene | Yes | Upstream and Upper Facility Reaches are significantly greater than Lower Facility and Downstream. |
| Toluene | Yes | Upper Facility Reach is significantly greater than remaining reaches. |
| Bis(2-ethylhexyl)phthalate | Yes | Upper Facility Reach is significantly greater than remaining reaches. |

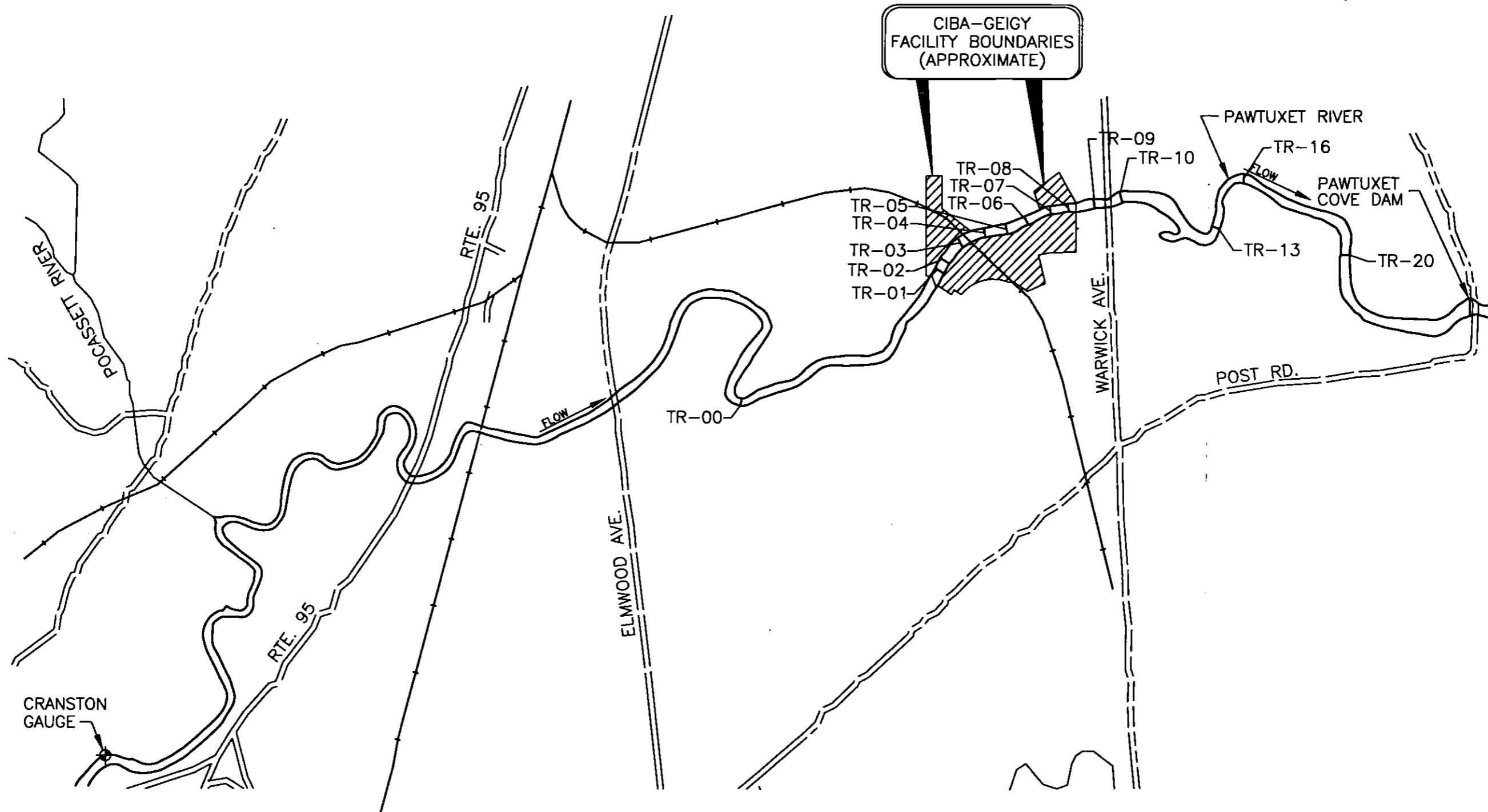
Note: All tests for significant differences at 0.05 level of significance.

TABLE 4-20
RESULTS OF MEAN COMPARISON TEST
UPPER FACILITY REACH SEDIMENTS BY DEPTH

| Phase II Analyte | Statistical Difference | Comments |
|----------------------------|------------------------|--|
| Copper | Yes | Surface sediments are significantly greater than subsurface sediments. |
| Silver | Yes | Surface sediments are significantly greater than subsurface sediments. |
| Zinc | Yes | Surface sediments are significantly greater than subsurface sediments. |
| Arsenic | Yes | Surface sediments are significantly greater than the 1 - 2 foot sediments. |
| Lead | Yes | Surface sediments are significantly greater than subsurface sediments. |
| PCBs | No | There is no significant difference between depths. |
| Chlorobenzene | No | There is no significant difference between depths. |
| Naphthalene | Yes | Surface sediments are significantly greater than subsurface sediments. |
| Toluene | Yes | Surface sediments are significantly greater than subsurface sediments. |
| Bis(2-ethylhexyl)phthalate | Yes | Surface sediments are significantly greater than subsurface sediments. |

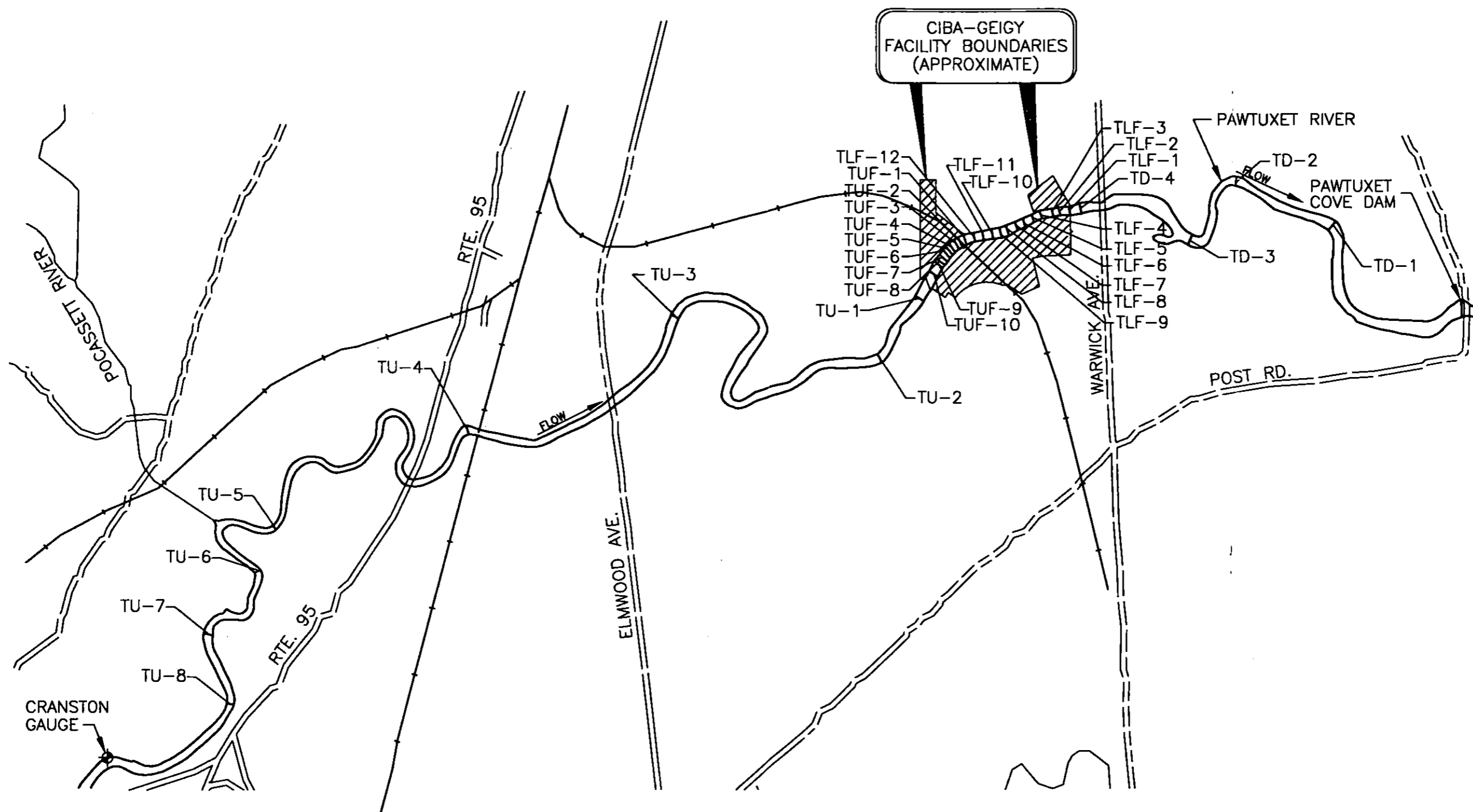
Note: All tests for significant differences at 0.05 level of significance.

Figures



0 600 1200 2400
SCALE (FEET)

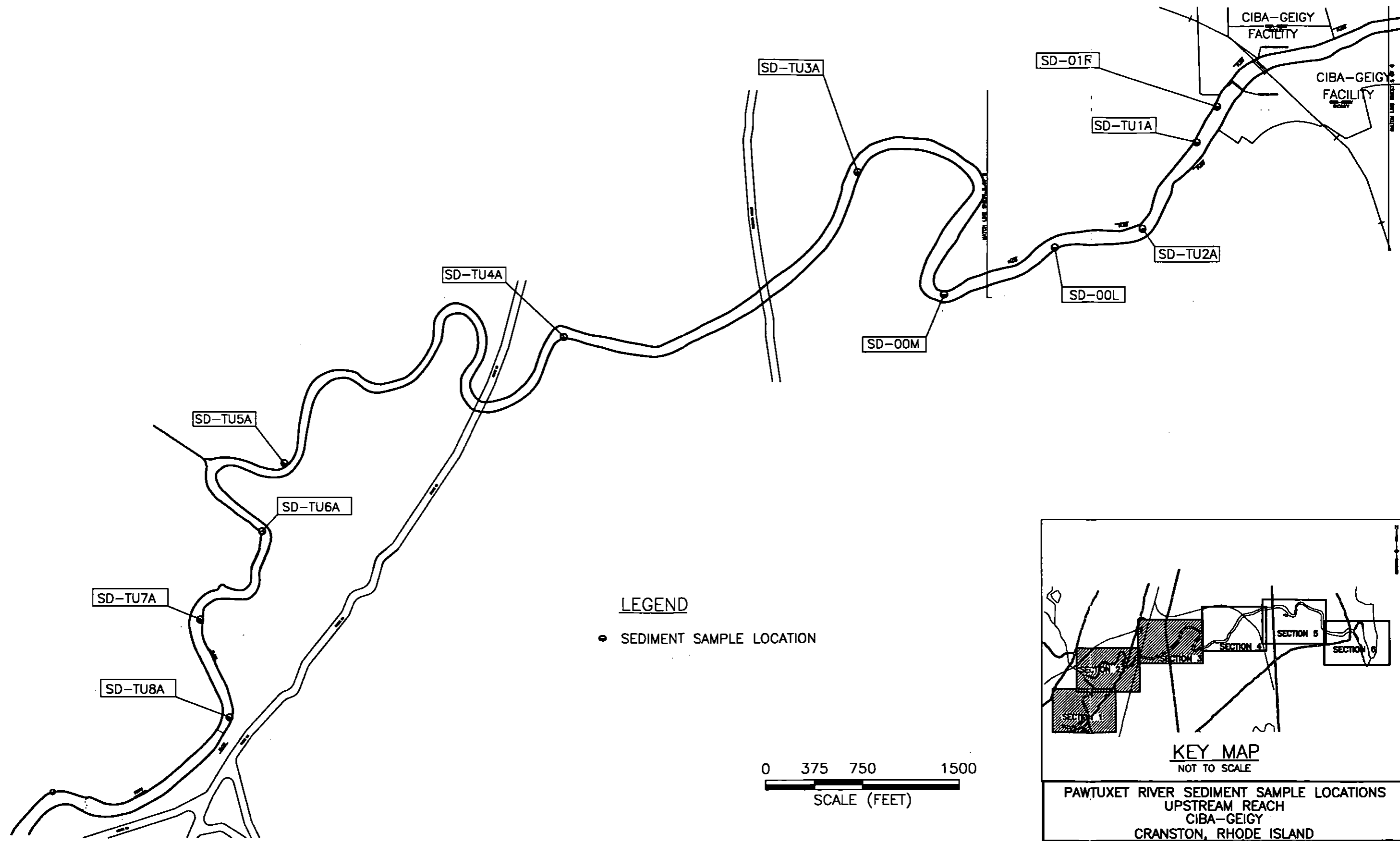
| PHASE 1 TRANSECT LOCATIONS CIBA-GEIGY CRANSTON, RHODE ISLAND | | | | | |
|--|-----|-------|--------------|-------------------|-------------------|
| WOODWARD-CLYDE CONSULTANTS | | | | | |
| ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT WAYNE, NEW JERSEY | | | | | |
| DR. BY | MVB | SCALE | AS SHOWN | DWG. NO. 74680108 | PROJ. NO. 87X4860 |
| CK'D. BY | KAK | DATE | MAR 18, 1996 | FIG. NO. | 4-1 |



0 600 1200 2400
SCALE (FEET)

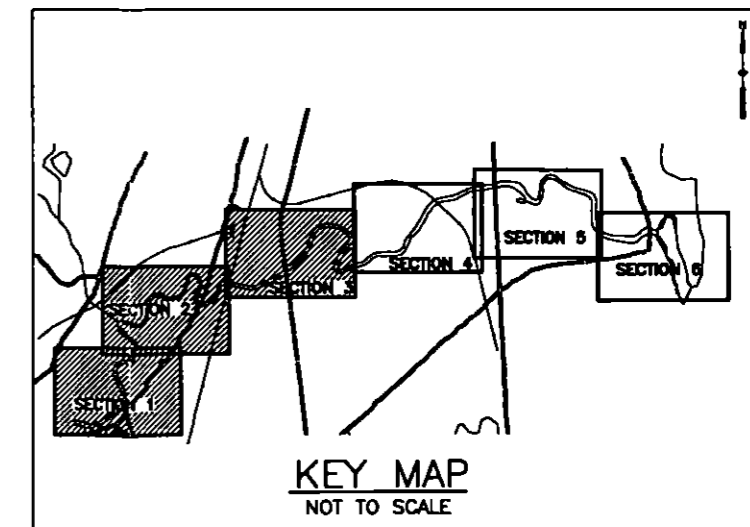
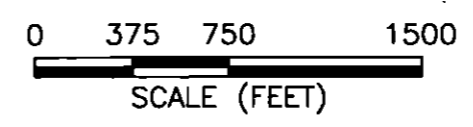
| PHASE 2 TRANSECT LOCATIONS CIBA-GEIGY CRANSTON, RHODE ISLAND | | | | |
|--|-----|-------|--------------|-------------------|
| WOODWARD-CLYDE CONSULTANTS | | | | |
| ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT WAYNE, NEW JERSEY | | | | |
| DR. BY | MVB | SCALE | 1" = 1200' | DWG. NO. 74660107 |
| CHK'D. BY | KAK | DATE | MAR 19, 1998 | FIG. NO. 4-2 |

File name: K:\CADD\87X4680\74680102.DWG Last edited: 98/03/25 @ 23:39



LEGEND

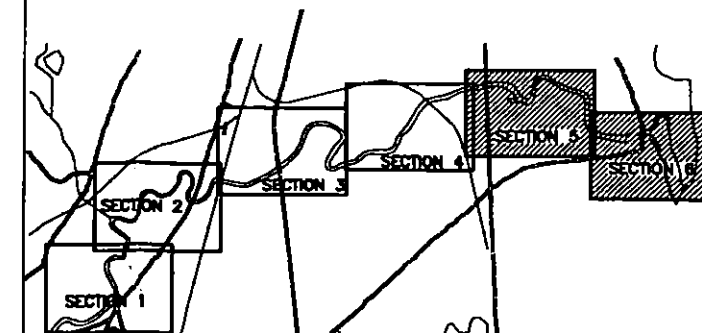
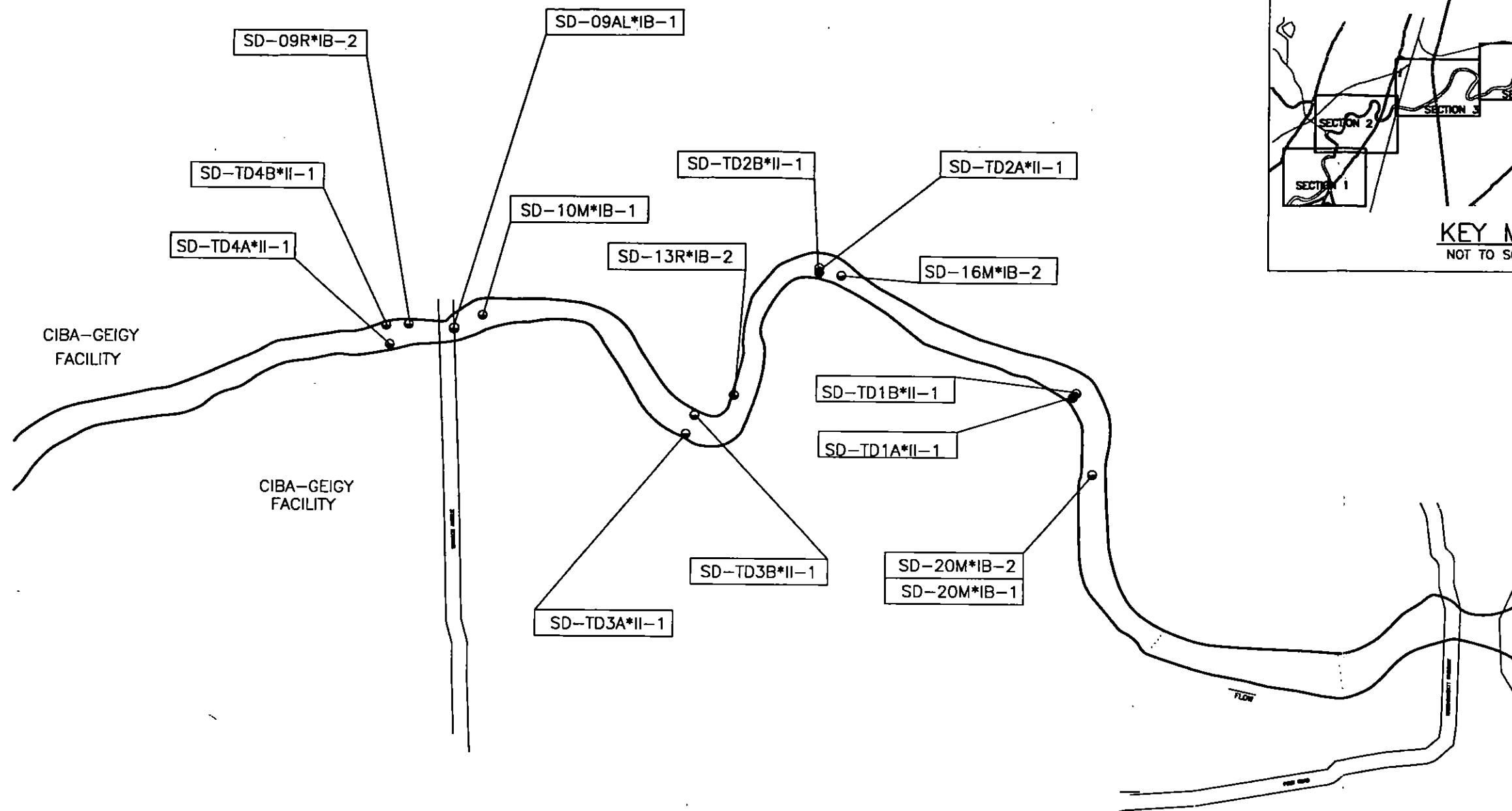
- SEDIMENT SAMPLE LOCATION



PAWTUXET RIVER SEDIMENT SAMPLE LOCATIONS
UPSTREAM REACH
CIBA-GEIGY
CRANSTON, RHODE ISLAND

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | | | |
|----------|-----|-------|--------------|-------------------|-------------------|
| DR. BY | JL | SCALE | AS SHOWN | DWG. NO. 74680102 | PROJ. NO. 87X4680 |
| CK'D. BY | KAK | DATE | MAR 18, 1998 | FIG. NO. | 4-3 |



KEY MAP
NOT TO SCALE

LEGEND

- SEDIMENT SAMPLE LOCATION

0 250 500 1000
SCALE (FEET)

PAWTUXET RIVER SEDIMENT SAMPLE LOCATIONS
DOWNSTREAM REACH
CIBA-GEIGY
CRANSTON, RHODE ISLAND

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ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

| | | | | | |
|----------|----|-------|--------------|-------------------|-------------------|
| DR. BY | JL | SCALE | AS SHOWN | DWG. NO. 74660104 | PROJ. NO. 87X4660 |
| CK'D. BY | AK | DATE | MAR 18, 1996 | FIG. NO. | 4-5 |

SUMMARY OF THE PAWTUXET RIVER MODELING INVESTIGATION

5.1 OVERVIEW

Ciba is conducting a RCRA Corrective Action Study for their Cranston, Rhode Island site (Figure 5-1). Between 1930 and 1986 the Cranston site was used for chemical manufacturing, initially by the Alrose Chemical Company, followed by the Geigy Chemical Company, and most recently by the Ciba Geigy Corporation. As part of this study, an investigation of the adjacent Pawtuxet River was conducted. The Pawtuxet River portion of the study included collection of water column and sediment contaminant data and development of a mathematical modeling framework to evaluate the fate and transport of contaminants in the river. The modeling framework provides a quantitative basis for evaluating the effects of various remediation alternatives on contaminant levels in the Pawtuxet River. A summary of the Pawtuxet River Modeling Investigation is presented here. The complete study is presented in Volume 2 of this Pawtuxet River RFI Report (March, 1996)

5.2 SUMMARY OF THE MODEL

The modeling framework used in this study represents the state-of-the-art in scientific understanding of the relevant environmental mechanisms influencing the transport and fate of contaminants in surface waters. The model is a mathematical representation of the transport and transfer processes that control the temporal and spatial distributions of a chemical in the environment. The framework is comprised of three sub-models, as depicted in Figure 5-2: the 1) hydrodynamic, 2) sediment transport, and 3) chemical fate components.

The hydrodynamic sub-model calculates spatial and temporal velocity (and flow) distributions, water depths, advective and dispersive mixing processes, and bottom shear stresses. The two dimensional, vertically integrated hydrodynamic model properly accounts for lateral variations in shear stress at the sediment-water interface, which strongly influences the transport and fate of sorbed chemicals due to cohesive sediment transport.

The sediment transport sub-model simulates the resuspension and settling of particulate material in the system and the concurrent transport of solids downstream. Because hydrophobic chemicals preferentially adsorb onto fine grained, cohesive sediments, the resuspension, deposition, and transport of cohesive sediments plays a critical role in the fate of hydrophobic chemicals in an aquatic system. Non-cohesive solids are generally less important as a sorptive phase for hydrophobic contaminants, but deposition of non-cohesive solids can provide a dilution of in-place contaminated sediments. The formulations used to describe non-cohesive sediment transport have been developed over a longer period of time, compared to the more recent advances in cohesive sediment transport. Both non-cohesive and state-of-the-art cohesive particle transport formulations are included in the sediment transport model applied to the Pawtuxet River, producing realistic simulations of suspended sediment transport processes. The results of the sediment transport sub-model provide input to the contaminant fate sub-model.

The contaminant fate sub-model uses the information generated by the hydrodynamic and sediment transport sub-models to define contaminant transport within the system. The fate sub-model is based on a mechanistic framework for the transport and transfer of contaminants in the aqueous environment. This sub-model includes such processes as dissolved-particulate partitioning, volatilization, settling, resuspension, and diffusion. The results of the contaminant fate model are estimates of future concentrations which vary in response to alternate remediation activities.

The general approach in the development of mathematical models of the fate and transport of chemicals in the environment is to: 1) collect and analyze relevant environmental data, 2) select and develop a model framework, 3) calibrate the model with ambient data, and 4) project future environmental conditions. These four steps have been followed in this study to produce a comprehensive model for determining the fate and transport of chemicals in the Pawtuxet River.

5.3 APPLICATION OF THE MODEL FRAMEWORK TO THE PAWTUXET RIVER

Contaminant data from surface water and sediments of the Pawtuxet River were analyzed to select a limited number of chemicals for modeling. Contaminants detected in the Phase I Release Characterization were ranked based on the toxicological significance of measured concentrations and/or evidence that the chemical was used or produced at the facility. A subset of five chemicals were

selected based on their ranking and the objective to have calibrated models for all of the major chemical classes. The five chemicals that were modeled are:

- Chlorobenzene
- Naphthalene
- PCBs
- Tinuvin 328
- Zinc.

Examples of calibration of the three submodels are shown on Figure 5-3. The hydrodynamic sub-model reproduces water surface elevations through two high flow events measured at Cranston in March 1992. The sediment transport model reproduces suspended solids data near the Ciba facility from the same time period. Water column chlorobenzene concentrations computed by the contaminant fate sub-model reproduce the decrease in concentration between the USGS flow gage at Cranston and the Facility, and the increase in concentration observed in the Facility Reach. Chlorobenzene concentrations in the sediment, computed during a two year period, indicate fairly constant sediment concentrations.

5.4 SUMMARY OF RESULTS

The primary objective in developing a contaminant fate and transport model of the Pawtuxet River is to provide a tool for the evaluation of the effect of alternate remedial measures on contaminant concentrations in the river. Sediment contaminant concentrations computed in projections for no action (base case) or alternate remediation scenarios are strongly influenced by sediment resuspension and deposition patterns within the study area. Resuspension within the study area can transport sorbed sediment contaminants to the overlying water. Re-deposition of sediments resuspended from within the study area is not a significant component in the depositional processes in this portion of the Pawtuxet River. Depositional patterns control how upstream sources of sorbed contaminants are distributed within the study area.

Results of the sediment transport sub-model are summarized on Figure 5-4. Net resuspension, indicated by negative bed elevation changes, is calculated in only limited areas. Net depositional rates

are generally low, less than 0.5 cm/yr, in the majority of the study area. Overall, the center channel is more stable than the more shallow areas along the north and south banks. Higher deposition rates, beginning near km 2.8 (~0.5km upstream of the facility), are due to a decrease in the bed slope in that area. The highest deposition rates are computed upstream of the Pawtuxet Cove Dam (downstream boundary) in response to backwater effects of the dam. In depositional areas, upstream sediments will gradually cover present surface sediments. Changes in sediment contaminant concentrations depend on deposition rates and contaminant concentrations on the depositing solids, relative to in-place sediment contaminant concentrations.

The contaminant fate sub-model was used to evaluate the response to two remedial measures: 1) operation of a groundwater capture system along the production area bulkhead and 2) excavation of a limited portion of the sediments from the location of a former Cofferdam, adjacent to the production area. Results from these 2 simulations are compared to results from a base case simulation representing no remedial action.

Figures 5-5 through 5-7 summarize projection results for three locations: 1) the former Cofferdam Area, where peak concentration of chlorobenzene, naphthalene, PCBs and Tinuvin 328 are presently observed, 2) on the south bank just upstream of the sharp bend in the river near km 1.25, and 3) on the south bank of the river immediately upstream of the Pawtuxet Cove dam. The latter two locations represent areas where peak concentrations of some of the 5 chemicals are calculated at the end of the projections. Zinc concentrations are presented for a fourth location, along the bulkhead of the Production Area upstream of the former Cofferdam Area. Peak concentrations of zinc are currently observed at this location.

No Action-Base Case

If no remedial actions are taken, the model indicates that natural attenuation will cause a reduction of contaminant levels in the area of the former Cofferdam. This reduction occurs largely through burial of sediments by less contaminated solids. The rate and extent of the reductions are dependent on the sedimentation rate and the contaminant concentrations on the water column solids. The concentrations of chlorobenzene, naphthalene, PCBs and Tinuvin 328 on water column solids are several orders of magnitude lower than in the surface sediment at the location of the former Cofferdam. Thus, the

contaminated sediments are being buried by essentially clean solids. Reductions of about 70 percent are predicted at the location of the former Cofferdam for each of these chemicals after 10.6 years. In contrast, surficial sediment zinc concentration declines by less than 25 percent as a result of relatively high zinc concentrations on water column solids which enter the upstream boundary at Cranston and settle onto the sediment.

Concentrations in the former Cofferdam Area subsurface sediments are also affected by deposition. Concentrations in the 5-10cm layer decline to a lesser extent than the surficial sediments (0-5 cm), reflecting the transport of contaminated sediments from the surface layer to the subsurface layer. The reductions vary depending on the initial concentration gradient in the sediments. The net decline of PCBs is near zero. For all the other contaminants a decline of about 20 to 40 percent occurs after 10.6 years.

Outside the former Cofferdam Area, concentration changes are less dramatic. In general, the surficial sediments appear to be at or near steady-state with the water column and little change occurs. The greatest change occurs with zinc: concentrations increase by about a factor of two in most of the study area over the 10.6 year projection due to zinc entering the upstream boundary at Cranston.

Groundwater Capture at the Production Area

Ciba is implementing a groundwater capture system to block the migration of contaminants beneath the Production Area. This system will reverse the hydraulic gradient and draw approximately 0.1 cfs of river water through the sediments adjacent to the production area bulkhead. The groundwater capture is effective in reducing peak concentrations of chlorobenzene and naphthalene near the former Cofferdam area, and would be expected to be equally effective in reducing concentrations of other chemicals with similar partition coefficients. During the first three years of operation, chlorobenzene and naphthalene concentrations in the top 10 cm at this location are reduced to less than 0.1 ppm, which can be compared to final concentrations from the base case (no action) simulation for chlorobenzene of about 1000 ppm and 40 ppm of naphthalene. The groundwater capture system also produces approximately a 40 percent reduction in the peak zinc concentration. The groundwater capture system does not significantly affect sediment PCB or Tinuvin 328 concentrations.

Excavation of Sediments from the Former Cofferdam Area

Ciba excavated sediments from the location of the former Cofferdam in the fall of 1995. The concentration of PCBs and Tinuvin in the former Cofferdam area was significantly reduced by the excavation of sediments in that area. Ten years after excavation, PCB concentrations in the former Cofferdam area are calculated at 0.6 and 1.6 ppm in the top 5cm and 5-10 cm layers, respectively. These concentrations represent approximately a factor of 30 reduction compared to the concentrations calculated at the end of the base case run (22 and 45 ppm in the same two layers).

Sediment contaminant concentrations in areas away from Ciba's Production Area are not significantly affected by either remedial action, because current mass fluxes out of the Facility Reach do not significantly affect downstream sediment concentrations. Peak concentrations of each of the chemicals modeled, measured near the Ciba facility, are significantly reduced by the combination of the two remedial actions.

5.5 SUMMARY AND CONCLUSIONS

The significant findings of these analyses are:

- The lower 2.8 km of the study area (from approximately 0.5 km upstream of the Facility to the Pawtuxet Cove Dam) is, in general, a depositional area. Net resuspension is calculated in only very limited areas. Net deposition begins roughly 0.5 km upstream of the facility in response to a reduction in the slope of the river bed.
- Re-deposition of sediments resuspended from within the study area is not a significant component in the depositional processes in the study area. Therefore, sediment contaminant concentrations in downstream areas are not significantly affected by resuspension of contaminated sediment from locations within the study area.
- Deposition in the lower 2.8 km of the study area results in gradual burial of surficial sediments with upstream water column solids. The change in contaminant concentrations due to this

burial is a function of the local deposition rate and the relative concentration of contaminants in the sediment and on the depositing solids.

- Sediment concentrations of chlorobenzene, naphthalene and PCBs are fairly constant in locations away from the former cofferdam area, indicating that sediment - water column exchanges of these chemicals are near equilibrium. Most locations in the lower 2.8 kilometers of the study area experienced an increase in zinc concentrations in the sediment due to deposition of zinc contaminated solids. The zinc contaminated water column solids are associated with zinc entering the study area at the upstream boundary. Tinuvin 328 concentrations in most of the lower 2.8 km of the study area decreased in response to deposition of uncontaminated solids.
- Contaminant concentrations in sediments of areas away from Ciba's production area are not significantly affected by either remedial action (groundwater capture or excavation of sediment from the former Cofferdam Area) because current mass fluxes out of the sediments adjacent to the Production Area do not significantly affect the sediments in the downstream Pawtuxet River.
- Operation of the groundwater capture system along the production area bulkhead is effective in reducing peak concentrations of chlorobenzene and naphthalene. This remedial action should be equally effective in reducing the concentrations of other chemicals with similar partition coefficients. Chlorobenzene concentrations in the top 10 cm of the sediment of the former Cofferdam area decrease from over 3000 ppm to less than 0.1 ppm in the first two years of the simulation of the groundwater capture system. Naphthalene concentrations in the same area decrease from over 100 ppm to less than 0.1 ppm in the first three years of the simulation.
- Excavation of sediment from the former Cofferdam Area is effective in reducing concentrations of PCB, Tinuvin 328, and zinc at that location. Ten years after excavation, PCB concentrations in the top 5 cm and 5-10 cm layers are calculated at 0.6 and 1.6 ppm, respectively. These represent substantial reductions compared to concentrations calculated in the base case (no remedial action), which were 22 and 45 ppm in the top 5 cm and 5-10 cm layers, respectively. Tinuvin concentrations of 0.3 ppm, or less, in the top 10 cm, calculated ten years after

excavation, are significantly lower than concentrations of several hundred ppm, calculated at the end of the no action simulation. Zinc concentrations in the 0-5 and 5-10 cm layers are initially reduced from between 1000 and 3000 ppm to approximately 200 ppm as a result of the excavation. Deposition of contaminated solids from upstream gradually increase the sediment concentrations of zinc to approximately 550 and 330 ppm in the two layers, during the 10.6 year simulation.

- The combination of the two remedial actions produces substantial reductions in the peak concentrations of each of the five chemicals modeled. Table 5-1 summarizes the reduction in contaminant concentration in sediments near the Production Area, calculated over the course of the 10.6 year projection analyses. The indicated reductions of chlorobenzene and naphthalene concentrations are achieved in the first 2 and 3 years, respectively.

Table

**Table 5-1. Effect of Remedial Actions on
Contaminant Concentrations in Sediments Adjacent
to the Ciba Production Area over 10.6 Year
Projection**

| Chemical | Effective Action | Concentration at Production Area (mg/kg) | |
|---------------|------------------------|--|---------------------|
| | | Initial | Final |
| Chlorobenzene | Groundwater Capture | 3700 | 0.06 ⁽¹⁾ |
| Naphthalene | Groundwater Capture | 150 | 0.05 ⁽²⁾ |
| PCBs | Excavation | 66 | 1.6 |
| Tinuvin 328 | Excavation | 640 | 0.3 |
| Zinc | Excavation | 2800 | 330 |

Note:

¹ Achieved after 2 years

² Achieved after 3 years

Figures

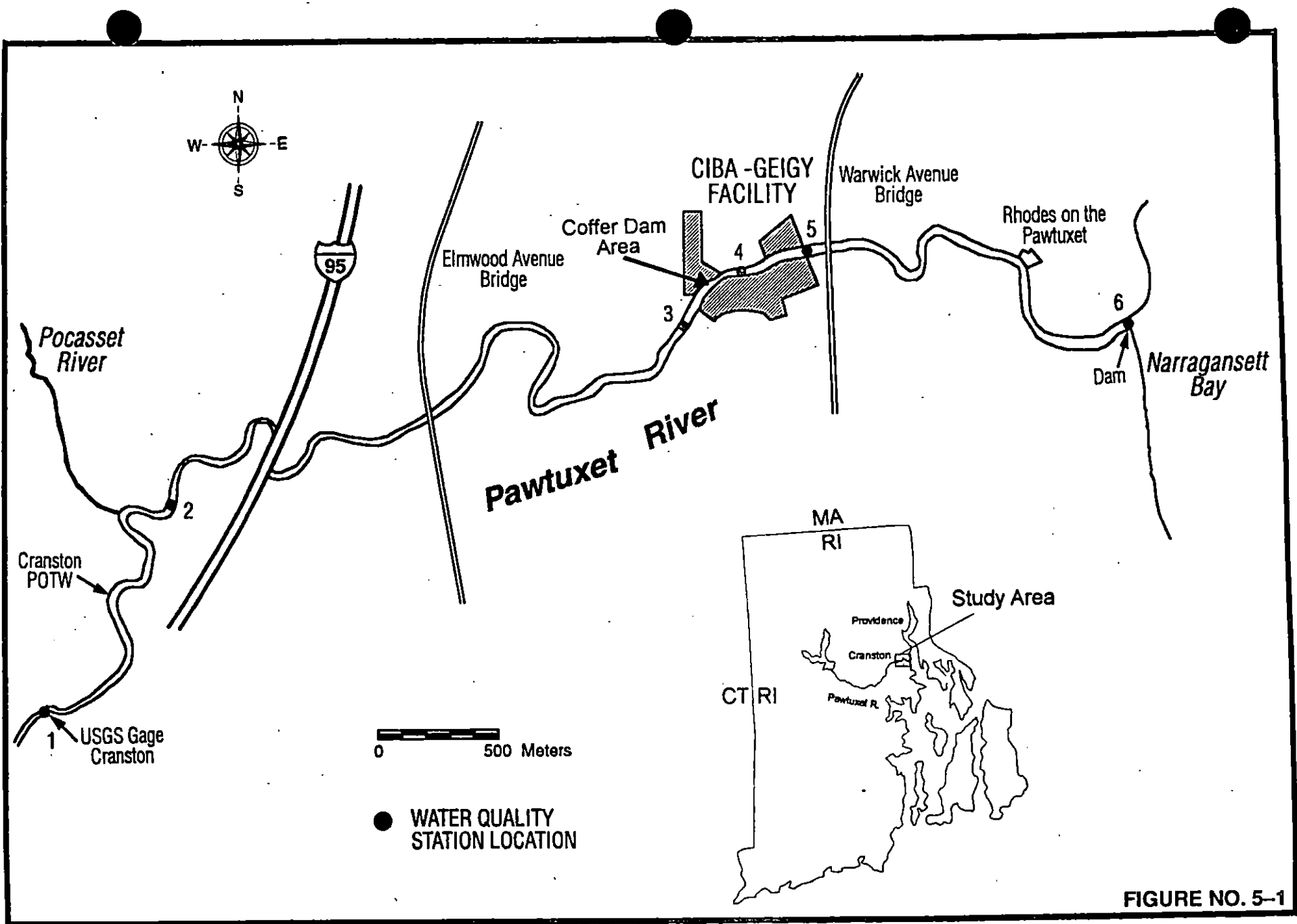
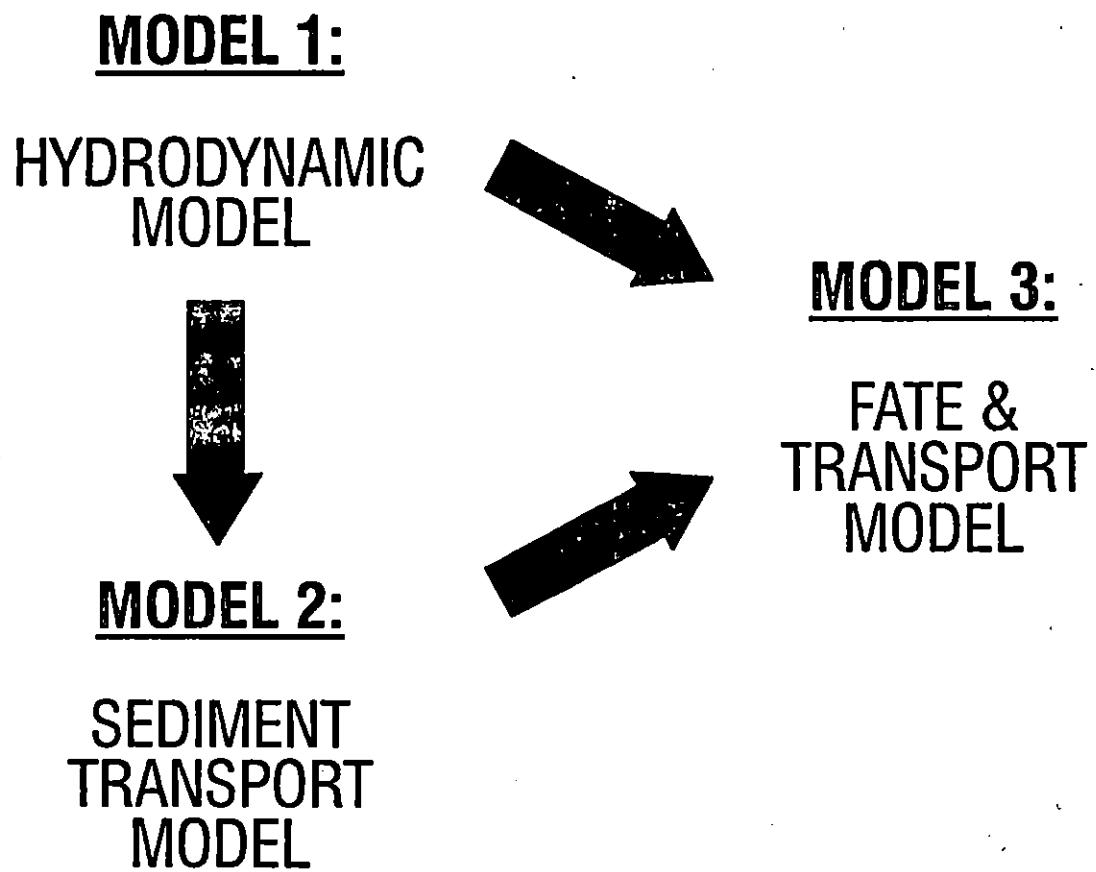
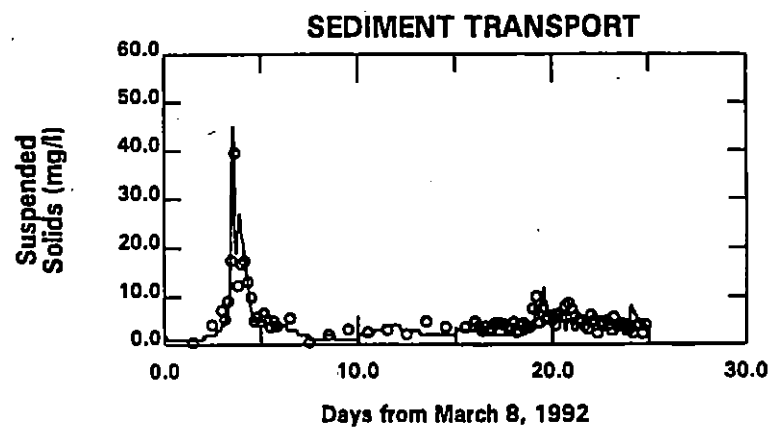
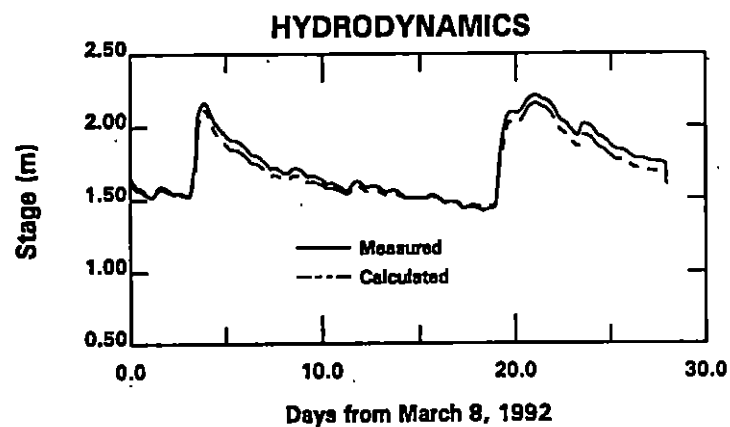


FIGURE NO. 5-1





CONTAMINANT FATE MODEL

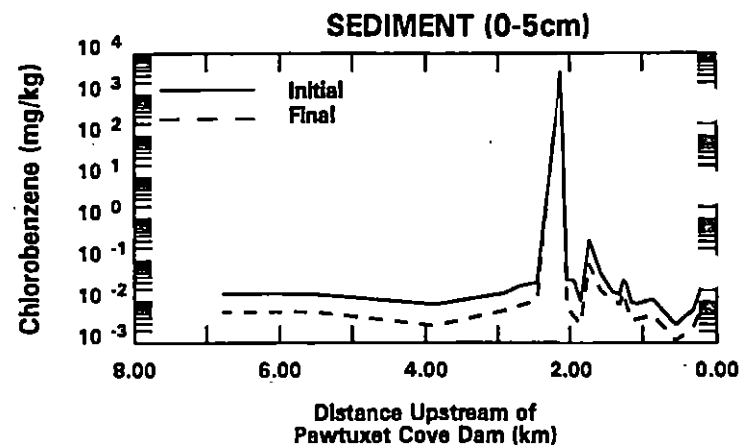
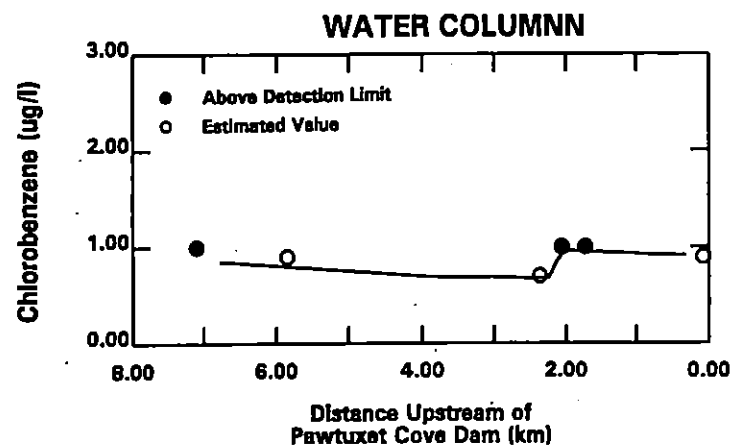


FIGURE NO. 5-3

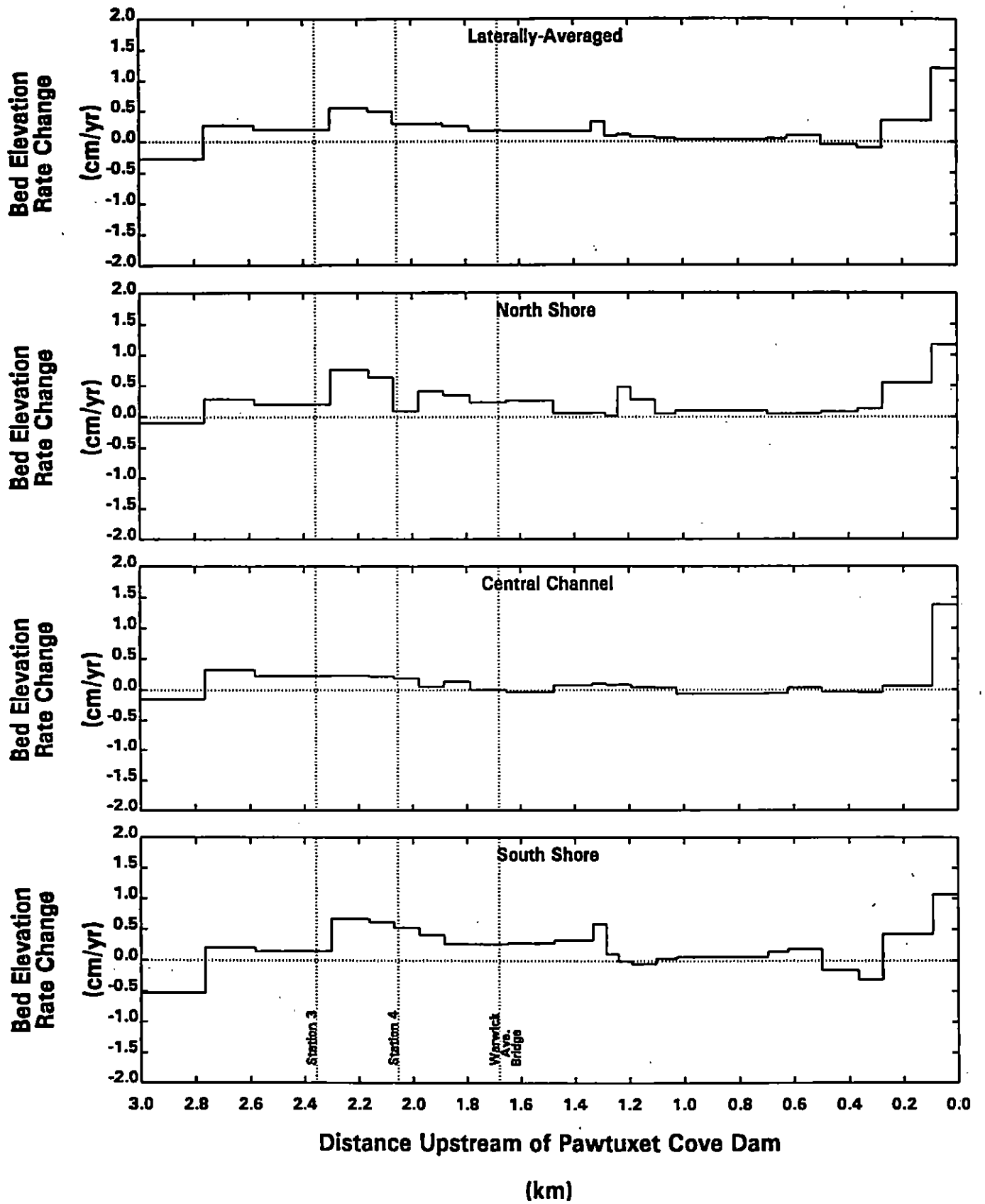


FIGURE NO. 5-4

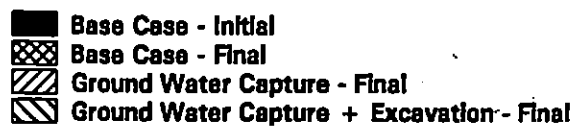
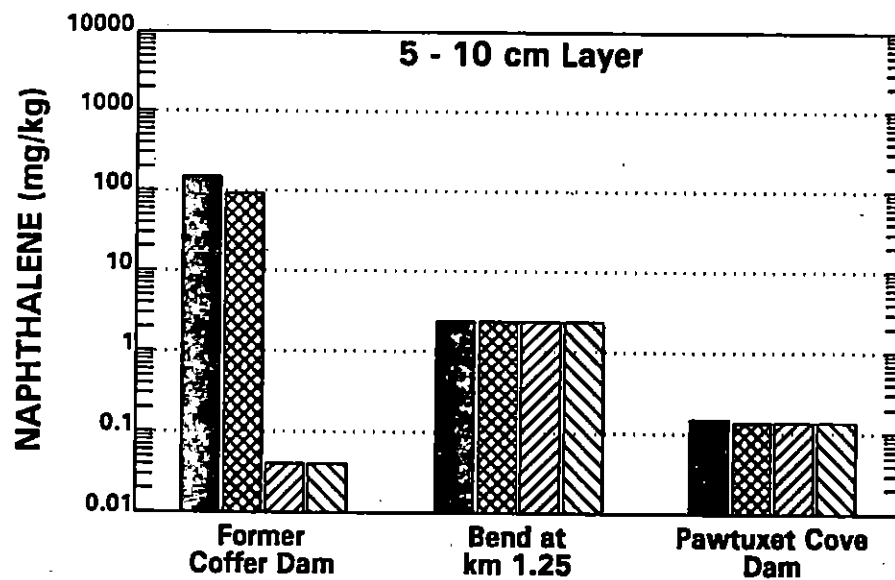
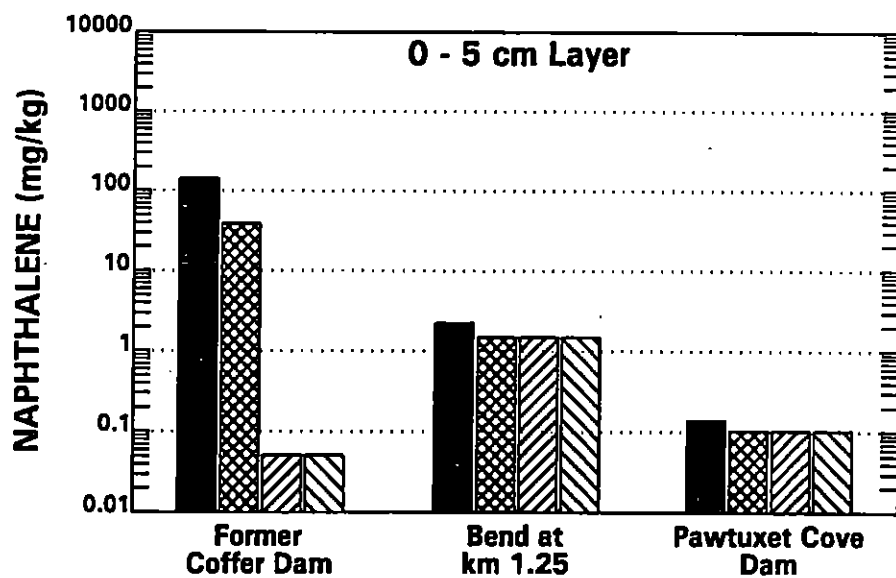
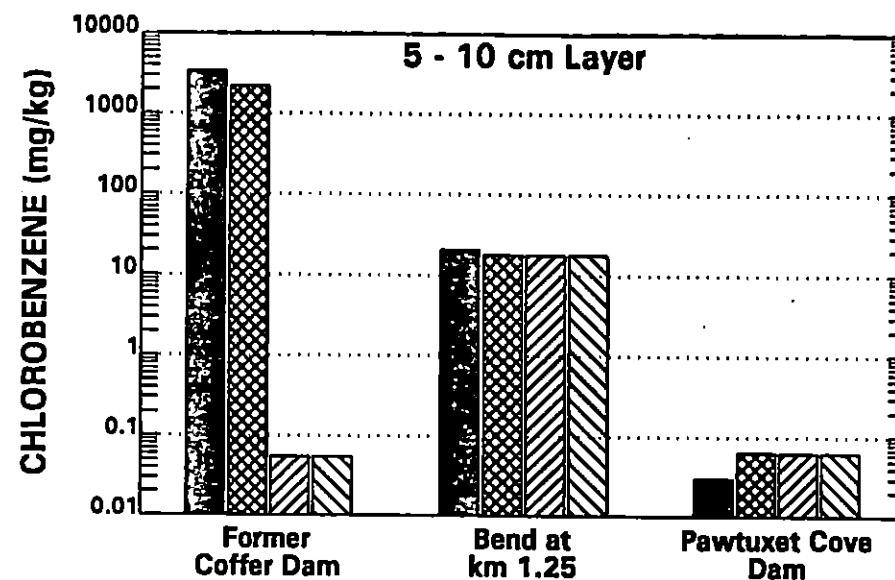
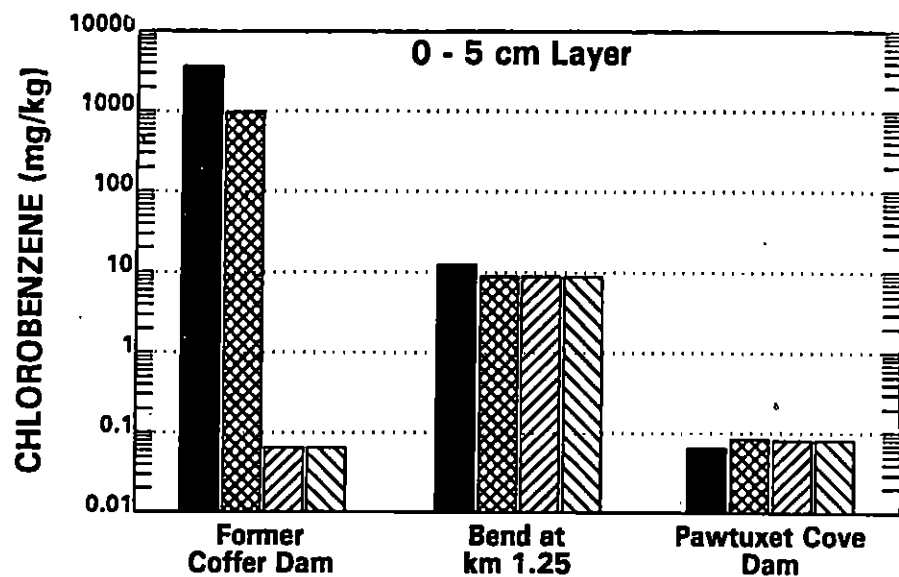


FIGURE NO. 5-5

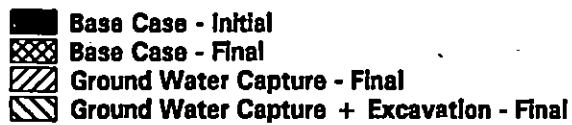
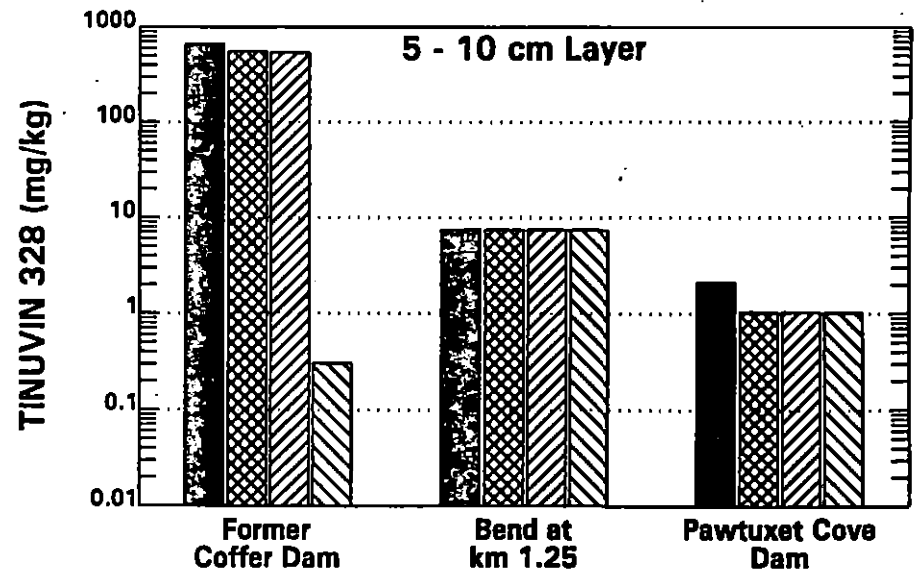
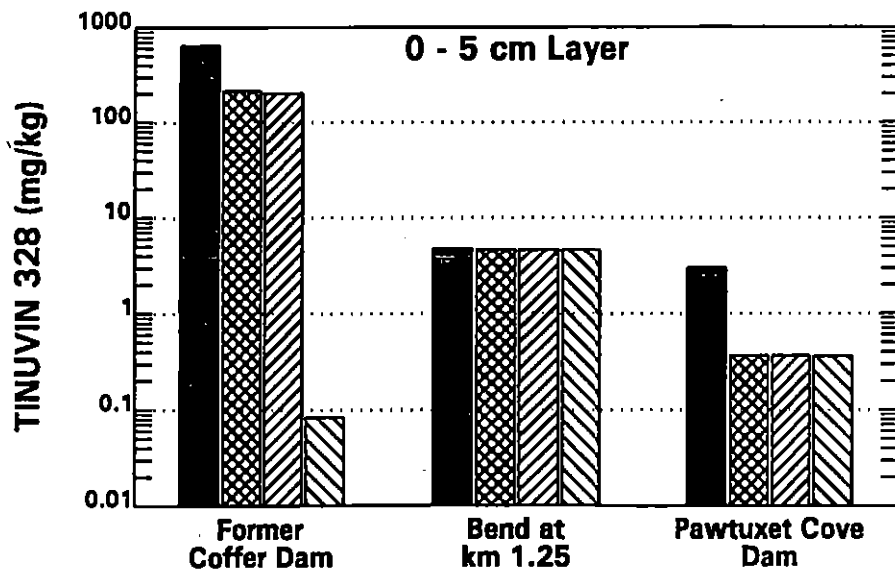
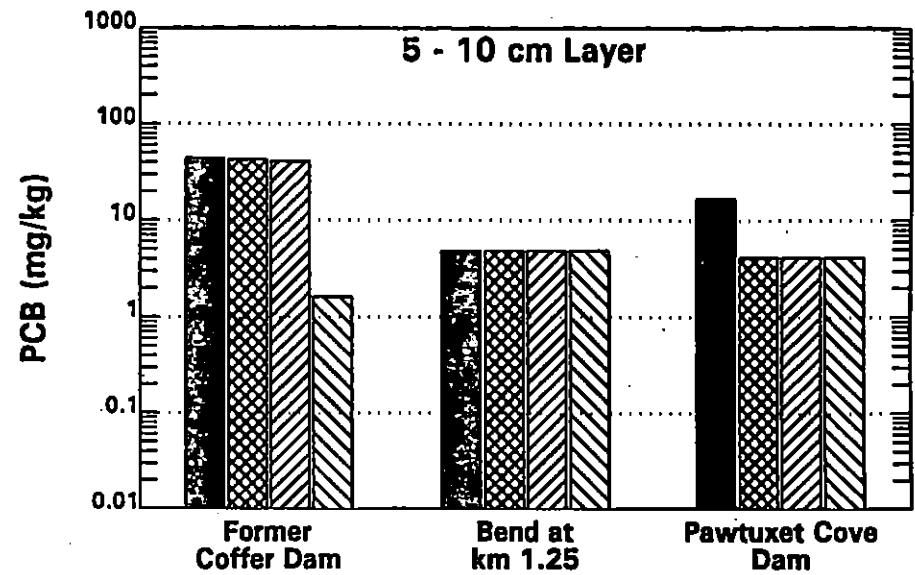
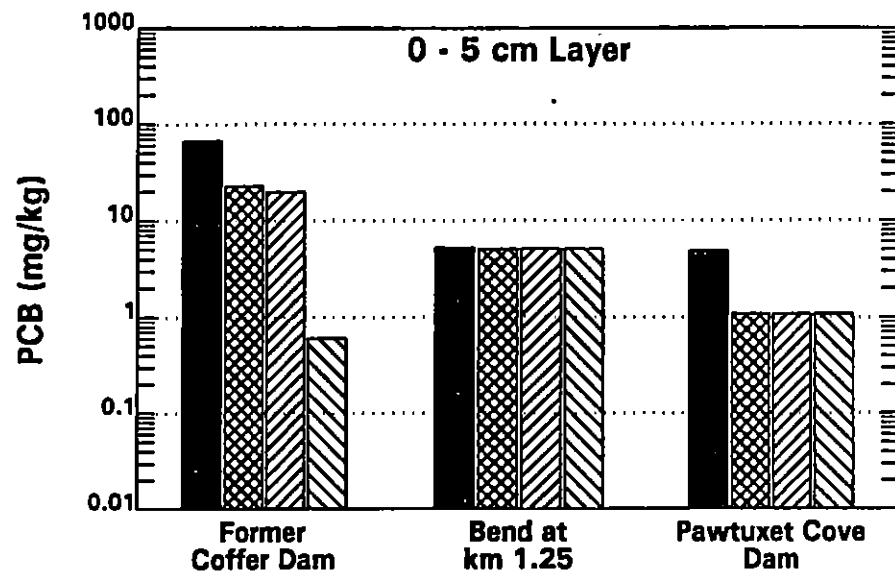
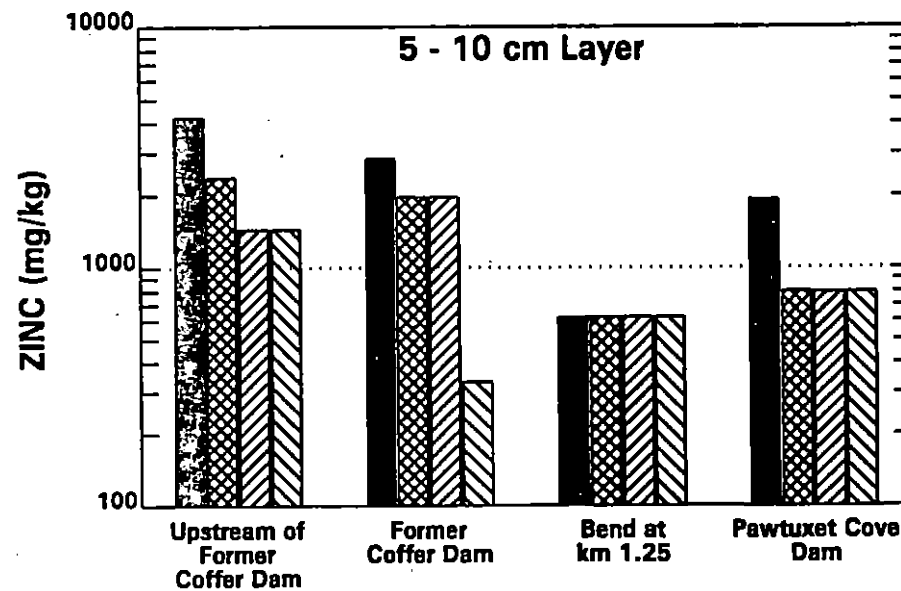
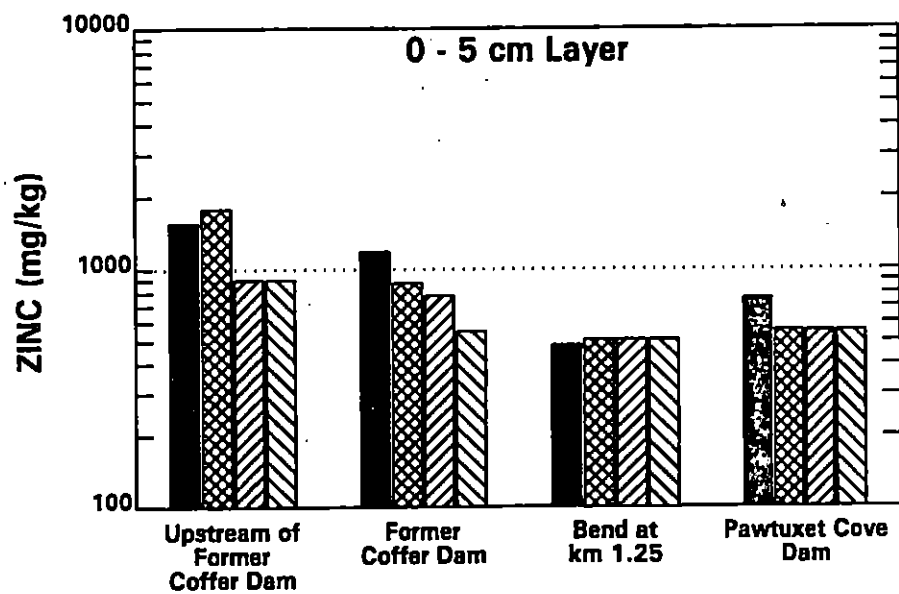


FIGURE NO. 5-6



■ Base Case - Initial
 ▨ Base Case - Final
 ▧ Ground Water Capture - Final
 ▩ Ground Water Capture + Excavation - Final

SUMMARY OF THE AQUATIC BASELINE ECOLOGICAL RISK ASSESSMENT

6.1 OVERVIEW

This baseline ecological risk assessment of the Pawtuxet River near the Ciba-Geigy (Ciba) facility in Cranston, Rhode Island (the Site), follows the process defined by the *Framework for Ecological Risk Assessment* (USEPA, 1992) and incorporates other USEPA guidance. The major Ciba industrial activities at the Site included the manufacture of agricultural products, leather auxiliaries, textile auxiliaries, plastics additives, optical brighteners, pharmaceuticals, and bacteriostats.

The main objective of this baseline ecological risk assessment is to evaluate the potential risks posed to ecological receptors by chemicals contained in Pawtuxet River surface sediment (0-0.5 feet) and surface water. Specific objectives are to:

- review ecological data,
- summarize the data into a description of ecological conditions of the Pawtuxet River near the Site,
- review data on the chemical contamination of the shallow sediment and surface water,
- develop a conceptual model to identify reasonable exposure pathways and potential ecological receptors, and
- characterize the potential for chemicals to induce adverse ecological effects.

The study of the Pawtuxet River is divided into four reaches (Figure 6-1). These are:

- Upstream Reach--from the meander bend near the USGS flow gauge at Cranston to the upstream facility reach boundary,
- Upper Facility Reach--from the upstream facility reach boundary to the railroad bridge,
- Lower Facility Reach--from the railroad bridge to the downstream facility reach boundary, and
- Downstream Reach--from the downstream facility reach boundary to the meander bend near Rhodes-on-the-Pawtuxet.

6.2 ENVIRONMENTAL FEATURES

The total area of the Site on which the RFI has been performed is approximately 27 acres: 11 acres north of the Pawtuxet River in Cranston and 16 acres south of the river in Warwick (Ciba, 1990). The topography of the Site is relatively flat with gentle slopes toward the Pawtuxet River

with elevations ranging from about 10 to 25 feet above mean sea level. The Pawtuxet River flows from west to east through the Site and is about 80 feet wide as it passes the Site. The entire Warwick Area, about half of the Waste Water Treatment Area, and about 10 percent of the Production Area are within the 100-year flood plain (FEMA, 1982, 1984).

The Pawtuxet River is designated by the U. S. Fish and Wildlife Service National Wetland Inventory system as R2OW, indicating a free flowing river (open water, lower perennial riverine system). Land use in the watershed includes rural, urban, and industrial. The Rhode Island State classification of water in the Pawtuxet River varies along the river, but is considered to be Class D downstream of the Cranston Sewage Treatment Plant; the Facility Reach is located within this area. Class D waters are suitable for migration of fish and have aesthetic value; they are not suitable for fishing or swimming.

The Pawtuxet River has received discharges from several sewage treatment plants and from many industries in the past and present. Before the industrial revolution (1800s), forges and textile mills discharged waste water and sewage to the river. Currently, the wastewater treatment plants of Warwick, West Warwick, and Cranston, as well as industrial metal plating operations and jewelry manufacturers discharge treated wastes to the river upstream of the Ciba facility. Water depth ranged from 2 to 9 feet along the facility reach during a bathymetric investigation conducted in July, 1990. Pools may have been caused by previous dredging activities or by erosional processes in the river. In general, shallow areas are colonized by aquatic macrophytes.

A terrestrial/riparian reconnaissance, a fish population survey, and a benthic invertebrate survey were conducted along the reaches. Stress tolerant species were found to dominate in the river. The fish population survey revealed that white suckers were numerically dominant at all areas surveyed. Common carp were abundant, particularly in the Upper Facility Reach. Golden shiner were common. The benthic invertebrate survey indicated that tubifex worms were the numerically dominant species in the majority of samples. In addition to tubifex worms, various species of aquatic insect larvae, leeches, snails, and flatworms were identified.

Terrestrial habitats within the Site include upland and riparian wooded and open areas. The upland open areas support plants typical of open fields, roadsides, and abandoned areas. The edges of wooded upland areas support plants such as staghorn sumac, the exotic tree-of-heaven, and multiflora rose which is also found in the wooded areas. English ivy and poison ivy serve as both ground plants and vines in all areas. Trees found in upland areas include black oak, which prefers drier sites, and species which are more tolerant of moisture variations. Also found in the upland areas are three species of pine, which can tolerate more moisture variations and certain trees and shrubs which are more typical of riparian areas.

Two small wetlands and the Pawtuxet River riparian zone (wetland along the river shore) are on-site. There is no riparian vegetation in the Production Area. About 600 feet of shoreline in the

Wastewater Treatment Area consists of riparian habitat, while the Warwick Area has 1,600 feet of riparian vegetation along the shoreline.

Birds found on site include species which prefer open areas and forest edges such as killdeer, mourning dove, domestic pigeon, European starling, mockingbird, house sparrow, and American robin. Woodland and edge area birds include Coopers' hawk, red-tailed hawk, great horned owl, blue jay, common crow, black-capped chickadee, cardinal, dark-eyed junco, and song sparrow. Birds found on site preferring a riparian habitat include great blue heron, Canada goose, black duck, American widgeon, mallard, wood duck, hooded merganser, red-winged blackbird, and belted kingfisher.

Mammals on site utilizing both upland and riparian wooded and open areas include the eastern cottontail rabbit, eastern gray squirrel, muskrat, and raccoon with the latter two especially utilizing the riparian area.

6.3 BIOSURVEYS AND BIOASSAYS

Both the benthic invertebrate study and the fish survey indicate that all four river reaches are dominated by a few stress-tolerant species. Conversely, they also reveal a lack of stress-sensitive species. Using ecological indices of species richness, dominance, and diversity, the benthic invertebrate community study results show no clear patterns of environmental stress in relation to the facility. The fish survey indicates a general pattern of decrease in the percent abnormalities from upstream to downstream.

Surface water bioassay results show that surface water associated with the Site did not adversely affect the test organisms. Significantly increased mortality was observed in benthic test organisms for sediment from the Upper and Lower Facility Reaches. Downstream Reach sediments also produced toxicity in benthic test organisms, but to a lesser extent than those in the two Facility Reaches. Toxicity to Upstream Reach benthic test organisms did not significantly differ from that of the laboratory control. However, the Upper Facility, Lower Facility, and Downstream Reaches are in an area of deposition, whereas the Upstream Reach is in an area where little deposition occurs. Thus, sediment contaminants will be found sorbed to particles in this depositional area. **This complicates the interpretation of the sediment bioassay and precludes the conclusion that all the toxicity observed in the facility reaches is site-related.**

6.4 PROBLEM FORMULATION

The physicochemical characteristics of the Pawtuxet River were investigated for the four river reaches. These characteristics include: river flow, bathymetry, riverbed sediment characteristics, drainage patterns, suspended sediment levels, and location and thickness of sediment deposits.

Sediment characteristics evaluated include: pH, grain size, bulk density, total organic carbon, cation exchange capacity, and chemical analyzed.

Exposure pathways to chemical contaminants were identified. These include the following:

- direct contact (surface water/sediment),
- root contact (surface water/sediment),
- consumption (surface water and sediment) and,
- food web interactions.

Potential ecological receptors were also identified. Because evaluating risks posed by chemicals to each and every species present is not feasible, the following were selected as indicator species: benthic invertebrates, fish (bluegill), raccoon, and great blue heron. These species were selected as indicators because:

- they were observed near the Site,
- they filled a niche in the food web,
- suitable habitat is available for these species,
- they represent top predators or top predator prey species, and/or
- species-specific toxicity data was available for a number of chemicals.

The potential for adverse effects was addressed in this assessment through comparison of an observed exposure point concentration to a toxicity reference value (TRV), which is an experimental or derived no-observed-adverse-effect-level (NOAEL) for terrestrial and aquatic animals. A NOAEL is the dose or concentration at or below which a population of organisms may be exposed with no expected adverse impacts to any individuals. Thus, endpoints in this assessment were based on potential effects at the population level of biological organization (USEPA, 1989a). Measurement endpoints were published results of laboratory or field toxicity tests performed on aquatic invertebrate, fish, mammal, and avian species that share an operational relationship with previously defined assessment endpoints.

6.5 EXPOSURE CHARACTERIZATION

The potential for chemicals present in the sediment and surface water of the Pawtuxet River to adversely affect aquatic or terrestrial organisms is a function of the magnitude of the exposure and the sensitivity of the organism. The exposure characterization describes the approach and methods used to estimate the level of chemical exposure potentially encountered by environmental receptors. These receptors are represented by the indicator species: benthic invertebrates, bluegill, raccoon, and great blue heron. Separate exposure values were estimated for each of the four Pawtuxet River reaches for benthic invertebrates, bluegill, and raccoon.

Because of its relatively large home range, only a single exposure scenario which includes all four river reaches was assumed in estimating exposure for the great blue heron.

Exposure for benthic invertebrates and fish are primarily water-only exposures. Therefore, pore water concentrations were used as the exposure concentration (mg/l) for benthic invertebrates, and surface water concentration was used for the exposure concentration (mg/l) for fish.

Estimated exposure was calculated for great blue heron and raccoon based on dietary intake, water ingestion, and incidental sediment ingestion. These were modeled based on environmental concentrations, site-specific considerations, values derived from the literature, and contaminant-specific factors.

6.6 RISK CHARACTERIZATION

Risk characterization quantitatively defines the magnitude of potential risks to ecological receptors under a specific set of circumstances. It is the process of applying numerical methods and professional judgement to determine whether adverse effects are occurring or are likely to occur due to the presence of chemicals. Risk characterization addresses the following questions:

- Are ecological receptors currently exposed to site-related stressors at levels capable of causing harm, or is future exposure likely?
- If adverse ecological effects are observed or predicted, what are the types, extent, and severity of effects?
- What are the principle uncertainties associated with the risk characterization?

Risk from the measured contaminants was estimated for benthic invertebrates, fish, raccoon and heron by dividing the estimated exposure for each chemical to the respective TRV. This resulting value is the toxicity quotient (TQ). The TQ values provide a means for identifying those contaminants or classes of contaminants that are likely contributors to ecological effects observed in the river. For contaminants with the same mode of toxicity, summation of the TQ values provides a better estimate of the importance of those contaminants.

Overall population impacts from chemical stressors may be indicated qualitatively using the sum of all of the TQ values, termed the Ecological Toxicity Index (ETI). An ETI value of less than one is evidence that a chemical is unlikely to adversely affect the population, a value from 1 to 10 indicates that adverse effects may be possible, and an ETI value exceeding 10 indicates that adverse effects for the population are likely. Gross differences among locations in ETI values give some indication of the relative potential impacts of contaminants at each location on population dynamics. This index can only be interpreted qualitatively, because of differences in dose/response relationships among chemicals and because of additive, synergistic, antagonistic, or a lack of interactions among chemical effects.

The ETI and TQ results for the chemical classes which drive the ETI values are summarized by river reach (except the great blue heron) and indicator species in Table 6-1. Benthic invertebrates exceeded an ETI of 10 for all four river reaches, ranging from 30 (Upper Facility Reach--post-excavation) to 173 (Lower Facility and Downstream Reaches). The majority of estimated benthic invertebrate ETI values for the Upstream, Upper Facility, and Lower Facility Reaches is attributable to PAHs. In the Downstream Reach, PAHs and phenols comprise more than 90 percent of the ETI. Phenols are not "risk drivers" for benthic invertebrates in the former three reaches. The excavation of the cofferdam sediments reduced the invertebrate TQ values for several chemical classes in the Upper Facility Reach, most notably 4-chloroaniline, PAHs, and volatile organic compounds (VOCs). None of the ETI values for fish exceeded 10; these values ranged from 2 (Upper Facility Reach -- post-excavation) to 10 (Upstream Reach). Between 94 and virtually 100 percent of the fish ETI value for each reach is associated with estimated metals toxicity. Likewise, all of the reaches had Raccoon ETI values less than 10, ranging from 2 (Upper Facility Reach) to 9 (Lower Facility Reach). The estimated toxicity associated with metals comprises 70 to 95 percent of the raccoon ETI. If data collected prior to excavation were considered, the raccoon ETI for the Upper Facility Reach would be 55. The TQ for PCBs, dioxins, and furans contributed about 94 percent of this value. The river-wide ETI for the great blue heron is 12, slightly exceeding the criterion of 10. About 60 percent of the heron ETI is associated with estimated metals toxicity. Prior to the IRM, the estimated heron ETI would have been 13; the reduction of risk after the IRM is mostly due to the removal of PCBs, dioxins, and furans.

The estimation of baseline risk in the Pawtuxet River involves numerous conservative assumptions regarding contaminant exposure and toxicity. The use of assumptions is necessitated by gaps in current understanding of contaminant fate and toxicity and by the limits of the available data. The assumptions have two main effects: 1) they reduce the precision of the risk estimate; and 2) they limit the ability to infer the extent of ecological effect associated with the risk estimate. Generally most assumptions in the risk assessment are biased conservatively, tending to overestimate ecological risk. The uncertainties include representativeness of selected chemical concentrations for surface water and sediment, representativeness of the indicator species, accuracy of TRVs, effects of multiple chemicals, and the appropriateness of equations and input parameters used to model pore water concentration, fish concentrations, exposure to heron, and exposure to raccoon.

6.7 CONCLUSIONS

The following may be concluded from the site characterization, biosurveys, bioassays, and risk estimations performed as part of the baseline ecological risk assessment:

- The Pawtuxet River is ecologically stressed throughout the length studied. This is evidenced by a number of ecological indices, the dominance of stress-tolerant species, and the absence of stress-sensitive species. The risk estimation results in the Upper Facility, Lower Facility, and Downstream Reaches are essentially the same as those of the Upstream Reach, indicating no increased ecological impact in these areas. The compounds driving risks (PAHs, metals, etc.) are characteristics of urban and industrial areas. Discharges from the Ciba site have contributed very little to these risks.
- Surface water bioassay results show no toxicity in any of the four reaches.
- The sediment bioassay results indicate some toxicity in all four reaches when compared to laboratory reference sediment, although toxicity was significant in the Upper Facility, Lower Facility, and to a lesser extent the Downstream Reach. The bioassay results for the Upstream Reach sediment did show toxicity when compared to laboratory reference sediment. However, the former three reaches are in an area of deposition, whereas the Upstream Reach is in an area where little deposition occurs. Thus, contaminants will be found sorbed to sediment particles in this depositional area and leads to the conclusion that observed toxicity is impacted by both upstream and site-related sources.
- The IRM effectively reduced ecological risks in the Upper Facility Reach, where chemicals in the cofferdam sediments had previously contributed significantly to risks. In this reach, the IRM reduced the ETI values for raccoon by over 96 percent and benthic invertebrates by about 60 percent. Additionally, it reduced the river-wide ETI for the heron by about 9 percent.

Table

**Table 6-1
Summary of Estimated Risks***

| TOXICITY QUOTIENTS FOR BENTHIC INVERTEBRATES | | | | | |
|--|----------|-------------------|------------------|----------------|------------|
| Chemical Class | Upstream | Upper Facility | | Lower Facility | Downstream |
| | | Before Excavation | After Excavation | | |
| Metals | 2.6 | 4.4 | 2.4 | 4.5 | 4.5 |
| PAHs | 77.1 | 33.6 | 22.9 | 103.0 | 79.6 |
| PCBs/Dioxins/Furans | 0.0 | 4.2 | 0.0 | 0.2 | 0.1 |
| Organochlorine Pesticides | 7.3 | 6.4 | 2.6 | 36.6 | 10.2 |
| Organophosphorus Pesticides | 0.0 | 0.0 | 0.0 | 26.2 | 0.0 |
| VOCs | 0.4 | 6.8 | 0.2 | 0.0 | 0.1 |
| Phenols | 4.2 | 4.5 | 1.0 | 1.6 | 78.2 |
| 4-Chloroaniline | 0.3 | 12.9 | 0.0 | 0.0 | 0.0 |
| Other | 0.1 | 0.7 | 0.6 | 0.3 | 0.2 |
| Ecological Toxicity Index | 92 | 74 | 30 | 173 | 173 |

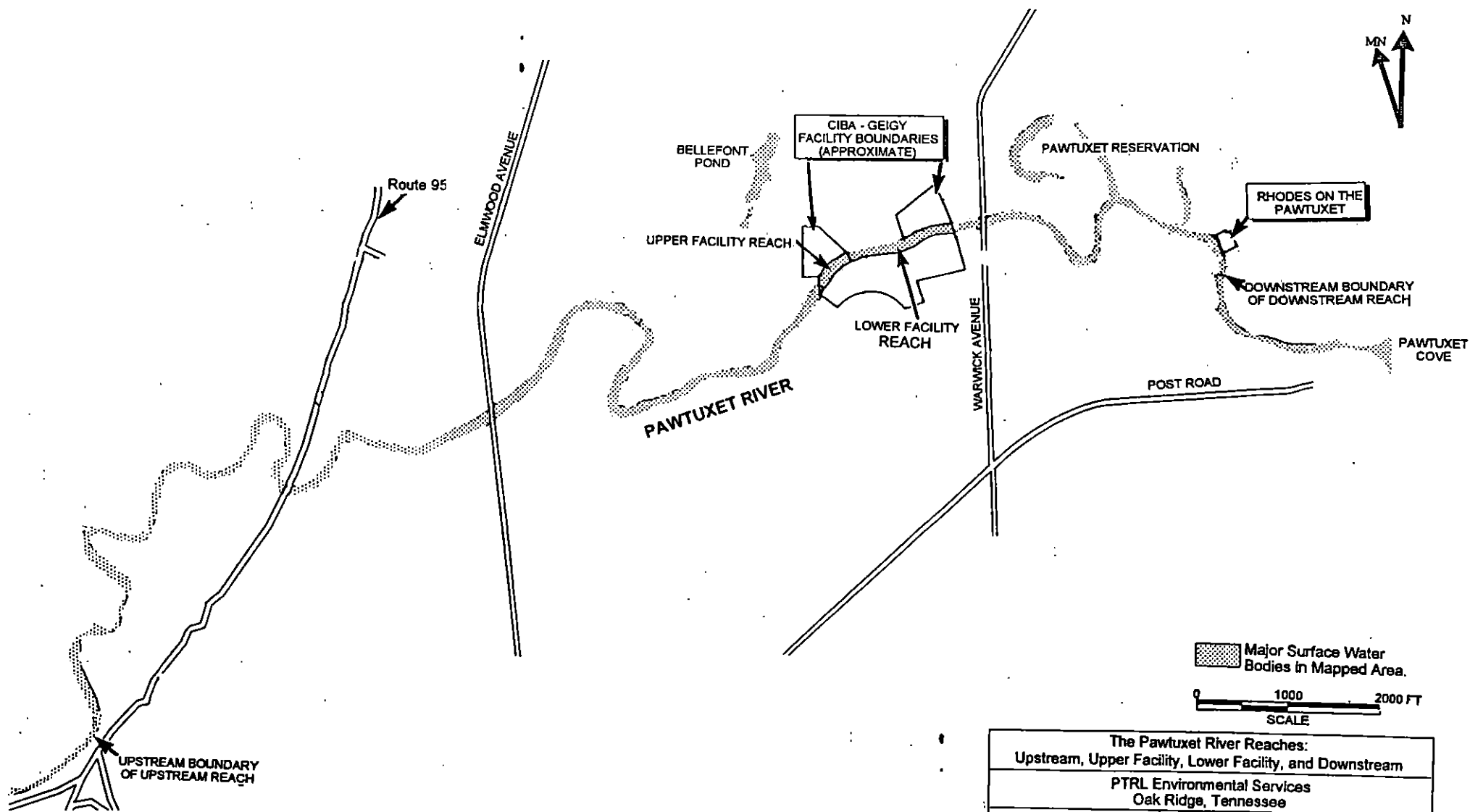
| TOXICITY QUOTIENTS FOR FISH | | | | | |
|-----------------------------|----------|-------------------|------------------|----------------|------------|
| Chemical Class | Upstream | Upper Facility | | Lower Facility | Downstream |
| | | Before Excavation | After Excavation | | |
| Metals | 10.1 | 5.9 | 5.9 | 7.7 | 7.0 |
| Other | 0.0 | 0.0 | 0.0 | 0.5 | 0.3 |
| Ecological Toxicity Index | 10 | 6 | 6 | 8 | 7 |

| TOXICITY QUOTIENTS FOR RACCOON | | | | | |
|--------------------------------|----------|-------------------|------------------|----------------|------------|
| Chemical Class | Upstream | Upper Facility | | Lower Facility | Downstream |
| | | Before Excavation | After Excavation | | |
| Metals | 3.6 | 2.7 | 1.7 | 6.3 | 4.2 |
| PCBs/Dioxins/Furans | 0.0 | 51.4 | 0.0 | 1.8 | 0.9 |
| Other | 0.4 | 0.6 | 0.1 | 0.7 | 0.8 |
| Ecological Toxicity Index | 4 | 55 | 2 | 9 | 6 |

| TOXICITY QUOTIENTS FOR HERON | | |
|------------------------------|-------------------|------------------|
| Chemical Class | River-Wide Total | |
| | Before Excavation | After Excavation |
| Metals | 7.3 | 7.2 |
| PCBs/Dioxins/Furans | 1.1 | 0.2 |
| Organochlorine Pesticides | 3.2 | 3.1 |
| Other | 1.2 | 1.2 |
| Ecological Toxicity Index | 13 | 12 |

* Includes the chemical classes accounting for >90% of the Ecological Toxicity Index of one or more river reaches.

Figure



| The Pawtuxet River Reaches: Upstream, Upper Facility, Lower Facility, and Downstream | | |
|---|----------------|----------------------|
| PTRL Environmental Services Oak Ridge, Tennessee | | |
| Drawn By: K. Evans | Scale 1:12000 | Project No. 2.008.01 |
| Checked By: R. McLean | Date: 03/11/96 | Figure 6-1 |

SUMMARY AND CONCLUSIONS

7.1 OVERVIEW

This document presented the results of the RCRA Facility Investigation (RFI) that was conducted for the Pawtuxet River near the former CIBA-GEIGY Corporation facility at Cranston, Rhode Island. The Pawtuxet River RFI involved five main tasks - a physical characterization, a source characterization, a release characterization, river modeling (hydrodynamic, sediment transport, and fate and transport of contaminants), and a ecological risk assessment. The findings of this RFI are summarized below.

7.2 SUMMARY OF THE PAWTUXET RIVER RFI

This section presents a summary of the five main tasks performed during the Pawtuxet River RFI.

7.2.1 Physical Characterization

The Pawtuxet River, within the study area, is a fourth order stream that drains about 230 square miles of mixed industrial and urban land. Flow in the river is regulated by reservoirs upstream. The river is classified by RIDEM as "Class D" upstream of the Site - Class D waters are suitable for migration of fish and have good aesthetic value, but should not be used for drinking or contact recreation. The average daily flow in the river is about 350 cfs. Highest flows occur in April; lowest flows occur in August. In the 4.5 mile section of river from the Cranston gauge to Pawtuxet Cove Dam, the river varies from about 60 to 200 feet wide, with mid-channel depths of 3 to 14 feet. Sediment thickness ranges from 0 to 4 feet thick, based on manual probing of the sediment. Depositional zones, or areas where sediments are thicker, tend to occur on the inside bends of the river and just downstream of large pools. Sediment within these depositional zones

is typically characterized by high Total Organic Carbon content, higher percentage of fine grained materials and higher Cation Exchange Capacities.

7.2.2 Source Characterization

The potential sources from on-site activities which may have impacted the Pawtuxet River include shallow groundwater from the Production and Warwick Areas and historical releases of waste water from the Waste Water Treatment Area. Also, sediment located within the old Cofferdam Area, adjacent to the Production Area, may have provided a source of contamination to the river prior to being excavated during the IRM.

7.2.3 Release Characterization

Results of this investigation show that releases of zinc, PCBs, chlorobenzene, toluene and bis(2-ethylhexyl)phthalate have impacted Pawtuxet River sediments in the immediate vicinity of the Site. Sediments within the Upper Facility Reach (adjacent to the Production Area) show statistically significantly higher concentrations of these analytes than sediments upstream or downstream of this reach. Sediment quality downstream of the Site is comparable to that upstream of the Site. The impact of releases from the Site appears to be localized in the sediment adjacent to the facility.

7.2.4 Modeling of the Pawtuxet River

The significant findings of the fate and transport modeling are:

- The lower 2.8 km of the study area (from approximately 0.5 km upstream of the Facility to the Pawtuxet Cove Dam) is, in general, a depositional area. Net resuspension is calculated in only very limited areas. Net deposition begins roughly 0.5 km upstream of the facility in response to a reduction in the slope of the river bed.
- Re-deposition of sediments resuspended from within the study area is not a significant component in the depositional processes in the study area. Therefore, sediment

contaminant concentrations in downstream areas are not significantly affected by resuspension of contaminated sediment from locations within the study area.

- Deposition in the lower 2.8 km of the study area results in gradual burial of surficial sediments with upstream water column solids. The change in contaminant concentrations due to this burial is a function of the local deposition rate and the relative concentration of contaminants in the sediment and on the depositing solids.
- Sediment concentrations of chlorobenzene, naphthalene and PCBs are fairly constant in locations away from the former Cofferdam Area, indicating that sediment - water column exchanges of these chemicals are near equilibrium. Most locations in the lower 2.8 kilometers of the study area experienced an increase in zinc concentrations in the sediment due to deposition of zinc contaminated solids. The zinc contaminated water column solids are associated with zinc entering the study area at the upstream boundary. Tinuvin 328 concentrations in most of the lower 2.8 km of the study area decreased in response to deposition of uncontaminated solids.
- Contaminant concentrations in sediments of areas away from the Production Area are not significantly affected by the operation of the groundwater capture or the excavation of sediment from the former Cofferdam Area. Current mass fluxes out of the sediments adjacent to the Production Area do not significantly affect the sediments in the downstream Pawtuxet River.
- Operation of the groundwater capture system along the Production Area bulkhead is effective in reducing peak concentrations of chlorobenzene and naphthalene. This remedial action should be equally effective in reducing the concentrations of other chemicals with similar partition coefficients. Chlorobenzene concentrations in the top 10 cm of the sediment of the former Cofferdam Area decrease from over 3000 ppm to less than 0.1 ppm in the first two years of the simulation of the groundwater capture system. Naphthalene concentrations in the same area decrease from over 100 ppm to less than 0.1 ppm in the first three years of the simulation.

- Excavation of sediment from the former Cofferdam Area is effective in reducing concentrations of PCB, Tinuvin 328, and zinc at that location. Ten years after excavation, PCB concentrations in the top 5 cm and 5-10 cm layers are calculated at 0.6 and 1.6 ppm, respectively. These represent substantial reductions compared to concentrations calculated in the base case (no remedial action), which were 22 and 45 ppm in the top 5 cm and 5-10 cm layers, respectively. Tinuvin concentrations of 0.3 ppm, or less, in the top 10 cm, calculated ten years after excavation, are significantly lower than concentrations of several hundred ppm, calculated at the end of the no action simulation. Zinc concentrations in the 0-5 and 5-10 cm layers are initially reduced from between 1000 and 3000 ppm to about 200 ppm as a result of the excavation. Deposition of contaminated solids from upstream gradually increase the sediment concentrations of zinc to about 550 and 330 ppm in the two layers, during the 10.6 year simulation.
- The combination of the two remedial actions produces substantial reductions in the peak concentrations of each of the five chemicals modeled.

7.2.5 Ecological Risk Assessment

PAHs are the greatest contributors to the ETI values for benthic invertebrates, and the summed TQ values for PAH's are high throughout the study area, suggesting that basin wide industrial activity has contributed significantly to elevated risk levels throughout the river. In the lower facility and downstream reaches, pesticides and phenols are the other major contributor to benthic invertebrate ETI values. There is no evidence that these were introduced from the Ciba facility.

The ETI for fish are relatively low and are uniform throughout the study area. Several fish species exhibit external abnormalities and the proportion of abnormalities decreases steadily from upstream to down. The fish collected in the Facility Reach do not exhibit a higher proportion of abnormalities.

Metals dominate the ETI values for the raccoon. there is no evidence that the primary contributors to the metal TQ sum (cadmium and thallium) were released by Ciba.

Thallium and pesticides dominate the ETI values for the heron. There is no evidence that Ciba released the chemicals that contribute to these values.

The biological observations are consistent with the TQ/ETI analysis in suggesting that the stresses are a river wide problem.

7.3 CONCLUSIONS

Volatile organic compounds (VOCs) in the shallow groundwater from the Production Area (AOC 13) have been detected in the sediments of the Pawtuxet River, however, they contribute little to the observed ecological stresses. Additionally, prior to 1975, process waste water was discharged to the Cofferdam Area adjacent to the Production Area, resulting in organic contamination (VOCs and PCBs) in localized sediments. There is no evidence of impact to the river from historical releases of wastewater (SWMUs 9, 10 and 12), or other SWMUs.

The interim groundwater capture system along the Production Area bulkhead is effective in reducing the peak concentrations of naphthalene, chlorobenzene and other chemicals with similar partition coefficients. The completed excavation of sediment from the old Cofferdam Area is highly effective in reducing concentrations of PCBs, VOCs, and zinc at that location.

Sediment transport and fate modeling have shown that re-deposition of sediment resuspended within the study area is not a significant component on the depositional processes in the study area. Therefore, sediment contaminant concentrations in the downstream areas are not significantly affected by the resuspension of contaminated sediment from locations within the study area. Sediment concentrations of chlorobenzene, naphthalene, and PCBs are fairly constant in locations away from the former Cofferdam Area, indicating that sediment-water column exchanges of these chemicals are near equilibrium.

The ecological assessment has involved the interpretation of biological observations within the river and estimation of the ecological risk posed by contaminants present in the sediment and water. These analysis indicate that the ecosystem of the Pawtuxet River is stressed and that contaminants are a probable causative factor. Further, the assessments indicate that discharges from the Ciba facility contribute little to the observed stresses, rather the contaminants (PAHs, metals, and pesticides) contributing significantly to risk are ubiquitous within the study area and are those typical of urban and industrial areas.

REFERENCES

- ASTM, 1990, Standard Test Method for Classification of Soils for Engineering Purposes. Designation D 2487-90.
- Brady, N.C., 1974, *The Nature and Properties of Soils*. Eighth Edition. MacMillan Publishing Co., Inc. New York.
- Ciba-Geigy Corporation, 1990, *Phase IA Report*, Ciba-Geigy Facility, Cranston, RI, October.
- Ciba-Geigy Corporation, 1991, *RCRA Facility Investigation Interim Report*, Ciba-Geigy Facility, Cranston, RI, November.
- Ciba-Geigy Corporation, 1991b, *Current Assessment Summary Report, Strategic Plan, and Facility Investigation Work Plan*, Ciba-Geigy Facility, Cranston, RI, February.
- Ciba-Geigy Corporation, 1992, *Phase II Pawtuxet River Proposal*, Ciba-Geigy Facility, Cranston, RI, January.
- Ciba-Geigy Corporation, 1995, *RCRA Facility Investigation Report On-Site Areas*, Ciba-Geigy Facility, Cranston, RI.
- Metcalf & Eddy, 1983, *Pawtuxet River, Rhode Island: Use Attainability Study*.
- SCS, 1981, *Soil Survey of Rhode Island*, United States Department of Agriculture, Soil Conservation Service.
- U.S. Department of Agriculture, 1977, *National Handbook of Recommended Methods for Water Data Acquisition*, Office of Water Data Coordination.
- U.S. Department of Agriculture, 1990, *Rhode Island Streams - 1978 - 88, An Update on Water-Quality Condition*, Water Resources Investigations Report 90-4082.
- USEPA, 1985, *Sediment Sampling Quality Assurance User's Guide*, EPA /600/4-85/048.
- USEPA, 1986, *Quality Criteria for Water*, Washington, D.C., EPA 440/5-86-001.
- USEPA, 1992, *Framework for Ecological Risk Assessment*. *Risk Assessment Forum*, U.S. Environmental Protection Agency, Washington, D.C., EPA/630/R-92/001.

LETTER REPORT



**SEDIMENT PROBING REPORT:
FORMER CIBA-GEIGY FACILITY
CRANSTON, RHODE ISLAND**

Prepared for:
Ciba-Geigy Corporation
Toms River Site
Toms River, NJ 08754

Prepared by:
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201 Willowbrook Boulevard
Wayne, NJ 07470

Project Number: 87X4660

November 11, 1994



November 11 , 1994
87X4660

Dr. Barry Berdahl, C.H.M.M.
Project Coordinator
Ciba-Geigy Corporation
Toms River Site
Route 37 West
Toms River, NJ 08754

**RE: RESULTS OF SEDIMENT PROBING AT THE CIBA-GEIGY FACILITY,
CRANSTON, RHODE ISLAND**

Dear Dr. Berdahl:

This letter report discusses the results of the sediment probing that was performed at the CIBA-GEIGY Facility at Cranston, Rhode Island. Sediment probing was conducted to visually delineate the horizontal "contaminated sediment" (thought to be waste) in the cofferdam area of the Pawtuxet River (as per the "Scope of Work Letter" dated September 20, 1994). The probing began on September 27, 1994 and was completed on October 13, 1994. A summary of the field measurements is presented in Table 1. Probing locations are shown in Figure 1 and visual sediment contamination maps are presented in Figures 2 and 3.

Scope of Work

The sediment probing was performed to delineate in two horizontal dimensions the extent of visually contaminated sediment below the river bed at the cofferdam area. Vertical delineation of the probing locations was not performed.

A five-foot grid was established near the cofferdam area and toward the middle of the channel, both upstream and downstream of the cofferdam area (Figure 1). The grid locations were situated along the bulkhead starting at the pedestrian walk bridge at the north shore (A1 grid node) and ending upstream of the railroad bridge (A40 grid node). The grid extends to the middle of the channel of the river going north (A nodes) to south (J nodes). Some grid nodes were not probed. In these areas, a clean edge was observed. We assumed that these sediments would remain visually clean as we continued to probe towards center channel.

The sediment was manually probed at the grid locations using a section of one-inch, schedule-80, PVC conduit. The probe was driven into the sediment at six-inch to one-foot intervals. Visual staining and refusal depths were recorded during probing. Grid location, refusal depth, first visual sign of staining and other pertinent observations were logged in a field note book.

Woodward-Clyde Consultants

Conclusions

The probing exercise provided data that helped delineate the horizontal extent of stained sediments. If the depth of contamination is estimated from sediment core SD-TUF-5C collected during the Phase II Round 2 Release Characterization (July 1994), then a volumetric calculation of contaminated sediment can be approximated.

Visual contamination was observed in core SD-TUF-5C down to a depth of 4.3 feet below grade. Sediment from 4.3 feet to 6 feet was visually clean. This core was the only core collected, at depth, in the area probed. The core was collected twenty-five feet from the bulkhead toward mid-channel. A depth of 4.3 feet was used to conservatively represent the depth of contamination in the areas discussed below.

The probing results showed two stained areas, one approximately 40 feet by 100 feet near the upstream end of the cofferdam and a second area, approximately 35 feet by 45 feet near the downstream end of the dam (Figure 2 and 3). Visibly stained sediments were first encountered at depths ranging from 0.5 to 4.5 feet below grade.

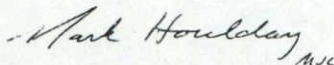
Based on the estimated areas of visual staining and the depth of visual contamination of core SD-TUF-5C (4.3 ft.) we have estimated, that approximately 964 cubic yards of sediment is visually contaminated. The quantity is probably underestimated, a better estimate can be made after the analytical results are integrated with field observations and the Media Protection Standards for the contaminants of concern are finalized.

Should you have any comments or questions, please feel free to contact us.

Very truly yours,



Edward Hastings
Assistant Project Scientist



Mark Houlday
Project Manager

Table

TABLE 1: SUMMARY OF SEDIMENT PROBING ON THE PAWTUXET RIVER (COFFERDAM AREA)

| Grid Location | Depth of First Visual Sign of Contamination (ft) | Depth of Refusal (ft) | Comments |
|---------------|---|--------------------------|---|
| A1 | 0 | 1.5 | Cement from bridge. |
| A2 | 0 | 1 | Silt |
| A3 | 0 | 4 | Silt |
| A4 | 3.5 | --- | White material in tube, brown staining. |
| A5 | 4 | --- | |
| A6 | --- | --- | No probing, next to P-30D. |
| A7 | 0 | 6.5 | |
| A8 | 0 | 5 | |
| A9 | 3.5 | --- | Br. stain, sand. |
| A10 | 0 | 4.5 | Sand |
| A11 | 0 | 6 | |
| B11 | 0 | 5.5 | |
| C11 | 0 | 6 | |
| D11 | 2 | --- | Heavy staining (localized?). |
| E11 | 0 | 4.5 | Cobble, gravel, sand. |
| F11 | 0 | 5 | Gravel, cobbles. |
| G11 | 0 | 1 | Rock. |
| H11 | 0 | 5 | |
| A12 | 0 | 6 | |
| B12 | 0 | 5 | |
| C12 | 0 | 5.5 | |
| D12 | 2 | --- | Heavy staining (localized?). |
| E12 | 0 | 5.5 | Gravel, sand. |
| F12 | 0 | 6.5 | |
| G12 | 0 | 5.5 | |
| H12 | 0 | 5.5 | |
| A13 | 0 | 2.5 | Tube had white specks and teal color sediment in it. |
| B13 | 0 | 5.5 | Silts, organic matter. |
| C13 | 0 | 5.5 | Sand, silt. |
| D13 | 3 | --- | Wood in probe in tip. |
| E13 | 0 | 5.5 | Sand, gravel. |
| F13 | 0 | 6 | Rock. |
| G13 | 2.5 | 0 | Slight staining. |
| H13 | 0 | 5.5 | |
| A14 | --- | --- | No probing, next to P-29D. |
| B14 | --- | --- | No probing, next to MW-29D. |
| C14 | 0 | 5 | Sand, gravel. |
| D14 | 0 | 4.5 | |
| E14 | 3 | 0 | |
| F14 | 0 | 4 | Sand. |
| G14 | 0 | 6 | |
| H14 | 0 | 3.5 | Sand, gravel. |
| I14 | 0 | 4 | Gravel. |
| A15 | 0 | 1.5 | Sand |
| B15 | 0 | 4 | Silty, clay. |

TABLE 1: SUMMARY OF SEDIMENT PROBING ON THE PAWTUXET RIVER (COFFERDAM AREA)

| Grid Location | Depth of First Visual Sign of Contamination (ft) | Depth of Refusal (ft) | Comments |
|---------------|---|--------------------------|-------------------------------|
| C15 | 0 | 4.5 | |
| D15 | 0 | 4.5 | |
| E15 | 6 | --- | Light staining. |
| F15 | 0 | 5.5 | Sand, gravel. |
| G15 | 0 | 5.5 | Sand, gravel. |
| H15 | 0 | 5 | |
| I15 | 0 | 5 | Gravel. |
| A16 | 0 | 2 | Sand, cobble |
| B16 | 0.5 | --- | |
| C16 | 0.5 | --- | |
| D16 | 0 | 6.5 | |
| E16 | 6 | --- | Light staining. |
| F16 | 0 | 6.5 | |
| G16 | 3 | --- | Slight staining. |
| H16 | 0 | 4.5 | |
| I16 | 0 | 5 | Sand, gravel. |
| A17 | 0 | 0 | Concrete Pad |
| B17 | | | No probing, concrete or rock? |
| C17 | 0.5 | --- | Heavy staining. |
| D17 | 0.5 | --- | |
| E17 | 1.5 | --- | |
| F17 | 4 | --- | Light staining. |
| G17 | 2.5 | --- | Light staining. |
| H17 | 0 | 7 | |
| I17 | 0 | 5.5 | Sand, gravel. |
| A18 | 0 | 1 | |
| B18 | 1 | --- | Silt. |
| C18 | 0.5 | --- | |
| D18 | 0.5 | --- | |
| E18 | 1.5 | --- | |
| F18 | 3.5 | --- | Light staining. |
| G18 | 0 | 4 | Gravel, sand. |
| H18 | 0 | 7 | Sand, gravel. |
| I18 | 0 | 6.5 | Sand, gravel. |
| A19 | 0 | 2 | Sand, gravel. |
| B19 | 0.5 | --- | Heavy staining. |
| C19 | 0.5 | --- | |
| D19 | 0.5 | --- | |
| E19 | 1.5 | --- | |
| F19 | 2 | --- | Light staining. |
| G19 | 0 | 4.5 | Gravel, rock. |
| H19 | 0 | 7 | Sand, gravel. |
| I19 | 0 | 7.5 | |
| A20 | 0 | 4 | |
| B20 | 0.5 | --- | |
| C20 | 0.5 | --- | |
| D20 | 0.5 | --- | |

TABLE 1: SUMMARY OF SEDIMENT PROBING ON THE PAWTUXET RIVER (COFFERDAM AREA)

| Grid Location | Depth of First Visual Sign of Contamination (ft) | Depth of Refusal (ft) | Comments |
|---------------|---|--------------------------|----------------------|
| E20 | 0.5 | --- | |
| F20 | 1 | --- | |
| G20 | 0 | 6 | Sand, gravel. |
| H20 | 0 | 5 | Sand, gravel. |
| I20 | 0 | 5.5 | |
| J20 | 0 | 5.5 | |
| A21 | 0 | 2 | Sand |
| B21 | 0.5 | --- | |
| C21 | 0.5 | --- | |
| D21 | 0.5 | --- | |
| E21 | 1 | --- | Sand. |
| F21 | 2 | --- | Sand, gravel. |
| G21 | 2.5 | --- | Sand. |
| H21 | 0 | 5 | Sand, gravel. |
| I21 | 0 | 6 | |
| J21 | 0 | 4.5 | |
| A22 | 0 | 3 | |
| B22 | 0.5 | --- | |
| C22 | 0.5 | --- | |
| D22 | 0.5 | --- | |
| E22 | 1.5 | --- | Sand. |
| F22 | 2 | --- | Sand, gravel |
| G22 | 2 | --- | Sand. |
| H22 | 3.5 | --- | |
| I22 | 0 | 5.5 | Sand, gravel. |
| J22 | 0 | 6.5 | Sand, gravel. |
| A23 | 0.5 | 0.5 | Refusal at .5 ft. |
| B23 | 0.5 | --- | |
| C23 | 1 | --- | |
| D23 | 2 | --- | Sand, silt. |
| E23 | 3.5 | --- | Sand, silt. |
| F23 | 3.5 | --- | Sand, gravel. |
| G23 | 2 | --- | Sand, gravel. |
| H23 | 3.7 | --- | Sand, gravel. |
| I23 | 0 | 5 | Sand, gravel. |
| J23 | 0 | 7.5 | Sand |
| A24 | 0 | 1 | Cobble, gravel |
| B24 | 0.5 | --- | |
| C24 | 1 | --- | Silt |
| D24 | 1.5 | --- | Sand, gravel. |
| E24 | 4 | --- | Sand, gravel. |
| F24 | 3.5 | --- | Sand, gravel. |
| G24 | 3.5 | --- | Sand, gravel. |
| H24 | 0 | 5 | Sand, gravel. |
| I24 | 0 | 5.5 | Sand, gravel. |
| J24 | 0 | 6.5 | Sand, gravel. |
| A25 | 0 | 2 | Cobble, gravel, sand |

TABLE 1: SUMMARY OF SEDIMENT PROBING ON THE PAWTUXET RIVER (COFFERDAM AREA)

| Grid Location | Depth of First Visual Sign of Contamination (ft) | Depth of Refusal (ft) | Comments |
|---------------|---|--------------------------|---|
| B25 | 2 | --- | Silt |
| C25 | 0 | 2 | Gravel, cobble, sand. |
| D25 | 2.5 | --- | Sand, gravel. |
| E25 | 4 | --- | Sand, gravel. |
| F25 | 3.5 | --- | Sand, gravel. |
| G25 | 0 | 6 | Sand, gravel. |
| H25 | 0 | 5 | Sand, gravel. |
| I25 | 0 | 5.5 | Sand, gravel. |
| J25 | 0 | 7 | Silt, sand. |
| A26 | 0 | 2 | Cobble, gravel, sand |
| B26 | 0.5 | --- | Cobble, gravel, sand. |
| C26 | 0 | 2 | Silt, sand, gravel, cobble. |
| D26 | 0 | 2.5 | Silt, sand, gravel, cobble. |
| E26 | 3 | --- | Sand, silt, gravel. |
| F26 | 4.5 | --- | Silt |
| G26 | 0 | 5.5 | |
| H26 | 0 | 5.5 | Sand, gravel. |
| A27 | 0 | 0 | Cobble, gravel pile. |
| B27 | 0 | 2 | Cobble, gravel, sand, silt. |
| C27 | 1 | --- | Sand, silt, gravel, cobble. |
| D27 | 1 | --- | Sand, silt, gravel, cobble. |
| E27 | 3.5 | --- | Sand, gravel |
| F27 | 4.5 | --- | Sand, end of probe had a thick tar like material on it. |
| G27 | 0 | 4.5 | |
| H27 | 0 | 5 | Sand, gravel |
| A28 | 0 | 0 | Cobble, gravel pile. |
| B28 | 0 | 1 | Cobble, gravel, sand, silt. |
| C28 | 0 | 5 | Sand, silt gravel, cobble. |
| D28 | 0 | 1 | Gravel, cobble, sand. |
| E28 | 2.5 | --- | Sand, silt. |
| F28 | 4 | --- | Sand. |
| G28 | 0 | 4 | |
| H28 | 0 | 5 | Sand, gravel |
| A29 | 0 | 0 | Cobble, gravel pile. |
| B29 | 2 | --- | Cobble, gravel. |
| C29 | 3 | --- | Sl. staining. |
| D29 | 0 | 4 | |
| E29 | 0 | 7 | |
| F29 | 0 | 4.5 | |
| G29 | 0 | 5 | Cobble, sand. |
| H29 | 0 | 5 | |
| A30 | 0 | 0 | Cobble, gravel pile. |
| B30 | 3 | --- | Slight staining. |
| C30 | 0 | 5 | |
| D30 | 0 | 4.5 | Cobble, gravel. |
| E30 | 0 | 6 | |

TABLE 1: SUMMARY OF SEDIMENT PROBING ON THE PAWTUXET RIVER (COFFERDAM AREA)

| Grid Location | Depth of First Visual Sign of Contamination (ft) | Depth of Refusal (ft) | Comments |
|---|---|--------------------------|---|
| F30 | 0 | 5 | |
| G30 | 0 | 5 | |
| H30 | 0 | 5 | |
| A31 | 0 | 0 | Cobble, gravel pile. |
| B31 | 0 | 5 | |
| C31 | 0 | 5 | |
| D31 | 0 | 5 | |
| E31 | 0 | 1 | |
| A32 | 0 | 3 | Sand, gravel. |
| A33 | 0 | 4 | Yellow-green powder in the bottom of the tube. |
| A34 | 0 | 3 | Silt. |
| A35 | 0 | 3 | Sand, silt. |
| A36 | 1 | --- | |
| B36 | 2 | --- | |
| C36 | 0 | 4 | |
| D36 | 1 | --- | |
| E36 | 1 | --- | |
| F36 | 0 | 2 | Gravel, sand. |
| G36 | 0 | 4.5 | |
| H36 | 0 | 5 | |
| A37 | 1.5 | --- | Sl. staining. |
| B37 | 0 | 4.5 | |
| C37 | 0 | 5 | |
| D37 | 0 | 2.5 | |
| E37 | 0.5 | --- | |
| F37 | 2 | --- | Heavy staining. |
| G37 | 0 | 4 | Sand. |
| H37 | 0 | 5 | |
| A38 | 0 | 3 | Sand, silt, gravel. |
| B38 | 4 | --- | |
| C38 | 0 | 3 | |
| D38 | 0 | 4 | |
| E38 | 0.5 | --- | Heavy staining. |
| F38 | 1 | 0 | |
| G38 | 1 | 0 | |
| H38 | 0 | 5 | |
| A39 | 0 | 3 | Silt, sand, gravel. |
| A40 | 0 | 2.5 | Sand, gravel. |
| Notes: | | | |
| Shaded Areas = Visual sign of staining. | | | |

Figures

FIGURE 1

SEDIMENT PROBING LOCATIONS

PAWTUXET RIVER (COFFERDAM AREA)

CIBA-GEIGY FACILITY

CRANSTON, R.I.

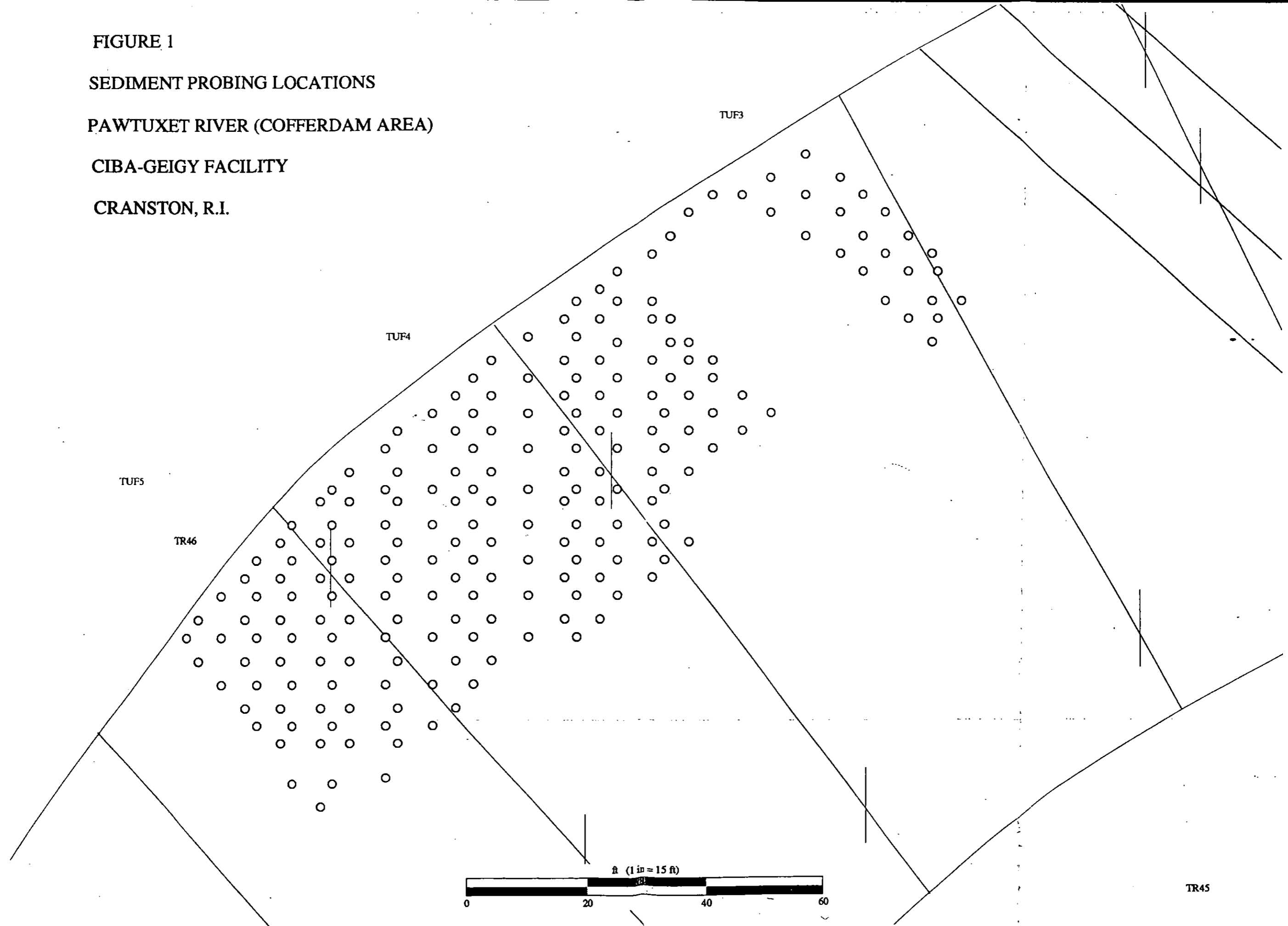


FIGURE 2

DEPTH TO VISUAL CONTAMINATION BELOW RIVER BED

PAWTUXET RIVER (COFFERDAM AREA)

CIBA-GEIGY FACILITY

CRANSTON, R.I.

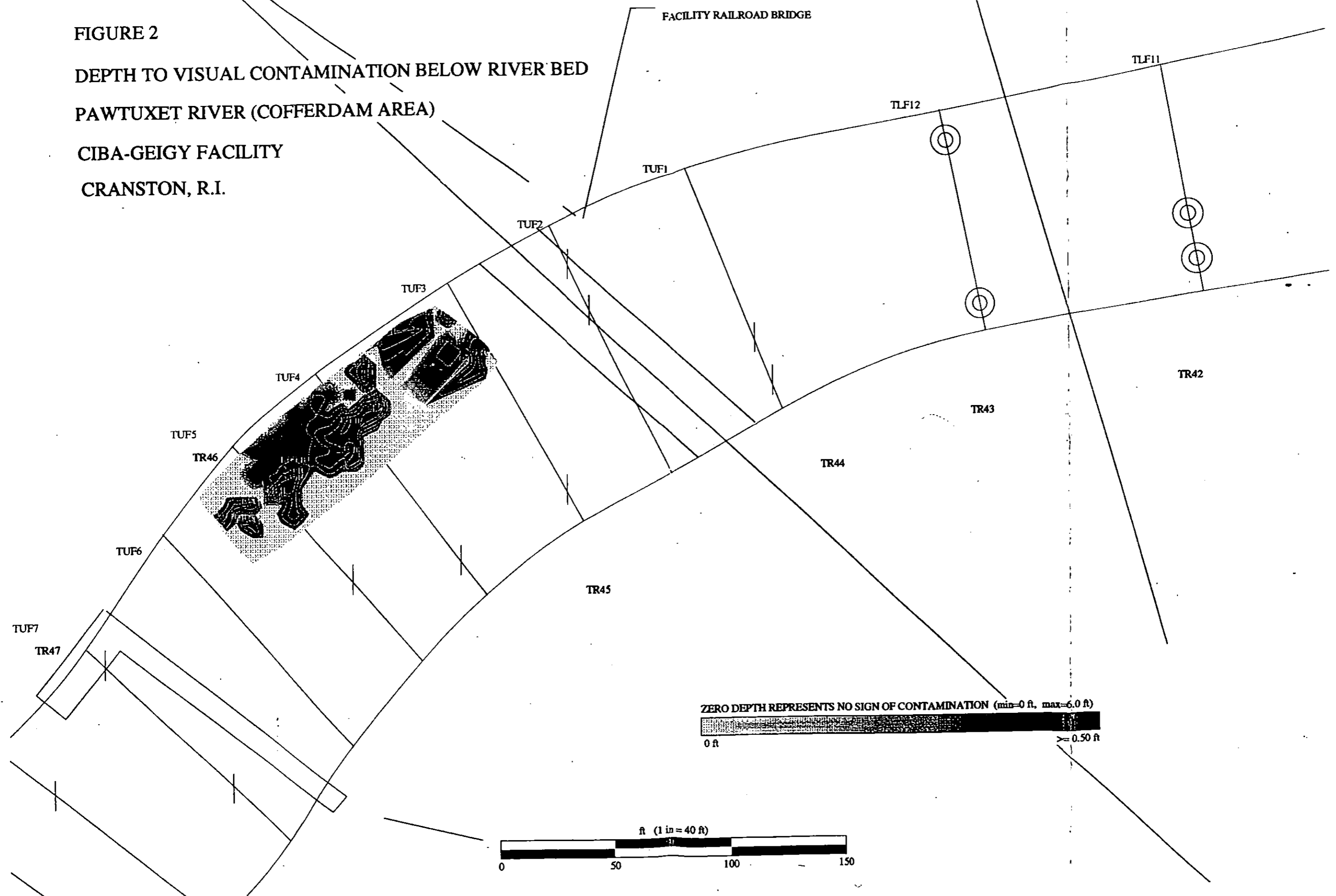


FIGURE 3

DEPTH TO VISUAL CONTAMINATION BELOW RIVER BED

PAWTUXET RIVER (COFFERDAM AREA)

CIBA-GEIGY FACILITY

CRANSTON, R.I.

